BULLETIN OF THE IMPERIAL INSTITUTE

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EPHESTIA ELUTELLA AND *E. CAUTELLA* INFESTING CACAO

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VOL. XXXIII. NO. 1

THE IMPERIAL INSTITUTE

South Kensington, S.W.7

GENERAL INFORMATION

THE Imperial Institute was founded as the Empire Memorial of the Jubilee of Queen Victoria. Its principal object is to promote the development of the commercial and industrial resources of the Empire.

Under the provisions of the Imperial Institute Act of 1925, the Institute was reorganised and placed under the control of the Department of Overseas Trade. The Parliamentary Secretary of that Department is the responsible Minister and is President of the Board of Governors. This body consists of the High Commissioners of the Dominions and India, representatives of the Colonial Office and certain other Government Departments, and of the Crown Agents for the Colonies, with additional members representing scientific and commercial interests. The Director of the Institute is Sir Harry A. F. Lindsay, K.C.I.E., C.B.E.

The technical work of the Institute is carried out by two principal Departments, viz. a Plant and Animal Products Department and a Mineral Resources Department. An Advisory Council for each of these groups of products has been appointed, Sir David Prain, C.M.G., C.I.E., F.R.S., being Chairman of the Plant and Animal Products Council, and Sir Richard Redmayne, K.C.B., Chairman of the Mineral Resources Council.

A number of Advisory Technical Committees consisting of authorities on the various groups of raw materials co-operate in the work of the Institute, in association with the Advisory Councils, and a close touch is main-

tained with producers, users, merchants and brokers. Valuable help can thus be given by the Institute to persons interested in the development of the resources of raw materials throughout the Empire.

Intelligence.—The Institute maintains a special service for dealing with enquiries relating to the sources, production, uses and marketing of raw materials and for collecting and disseminating general and statistical information on these subjects. This service is available for the use of individuals and firms, as well as of Government Departments.

Investigations.—The laboratories of the Institute are specially equipped for the chemical and technical examination of raw materials of all kinds. Full reports are furnished on the composition, uses and value of materials submitted. By its close association with the users of raw materials, the Institute is able to arrange large-scale trials of promising materials when necessary.

Special analyses and investigations are undertaken for firms or private persons in any part of the Empire on payment of appropriate charges. Applications for such investigations should be addressed to the Director.

Investigations on plantation rubber are conducted at the Institute under the supervision of the London Advisory Committee of the Ceylon Rubber Research Scheme and the Rubber Research Institute, Malaya.

Library.—The Library of the Institute contains a large collection of works of reference relating to Empire countries and their products and is regularly supplied with the more important reports and other publications of Government Departments in Great Britain, the Dominions, Colonies and India, and most foreign countries. More than 800 serial publications, mainly of a scientific or technical character, are also regularly received.

The library is available for the use of enquirers between the hours of 10 a.m. and 5 p.m. on week-days (10 a.m. and 1 p.m. on Saturdays).

Statistical Section.—This section is concerned with the collection of statistics required in connection with the work of the Institute.

Publications.—The BULLETIN OF THE IMPERIAL INSTITUTE contains records of the principal investigations conducted for the Dominions, Colonies and India at the Imperial Institute, and articles and notes, chiefly relating to progress in tropical agriculture and forestry, the development of mineral resources, and the industrial utilisation of all classes of raw materials. A summary of research work conducted by Government Technical Departments overseas and a special bibliography of publications received in the library of the Imperial Institute are also included.

Other publications of the Institute include a handbook on "The Agricultural and Forest Products of British West Africa"; a Descriptive List of Some Empire Timbers; a Report on Grading Rules and Standard Sizes for Empire Hardwoods; a Monograph on the Tanning Materials of the British Empire; Reports on the Collection of Reptile Skins for Commercial Purposes and the Drying of East African Hides; Monographs dealing with the Mineral Industry of the British Empire and Foreign Countries as well as a statistical series relating thereto; and a series of volumes on the Mining Laws of the British Empire and Foreign Countries. A list of the publications is obtainable on request.

Public Exhibition Galleries.—These galleries serve as a permanent exhibition of the natural resources, scenery and life of the people of the Dominions, Colonies and India. It is the only exhibition of the kind in the world where the countries of the Empire are represented under one roof.

A special feature has been made of pictorial representation, which takes the form of illuminated dioramas, transparencies and photographs. These are intended to attract the non-technical visitor and children, and to awaken in them an interest in the raw products which are shown in association with the illustrations. Descrip-

tive labels are attached to all exhibits explaining in simple language their origin, occurrence, methods of cultivation or preparation, and uses. To render the galleries of further assistance to teachers in the study of Empire geography and development, the exhibits are arranged in a definite sequence as suggested by the Advisory Education Committee of the Imperial Institute. Lectures and demonstrations in the galleries are given daily to school teachers and school children by the Guide Lecturers.

At the Central Stand which is maintained in the galleries for enquirers, free literature relating to Empire countries and products is distributed, and other publications and picture postcards are on sale.

In the Exhibition Pavilion, attached to the Galleries, temporary exhibitions of special products are held.

The galleries are open free on weekdays from 10 a.m. to 5 p.m. and on Sunday afternoons from 2.30 to 6 p.m.

Cinema.—The Imperial Institute maintains a Cinema Theatre in the Exhibition Galleries. The Cinema is equipped with modern projectors, screen, lighting, heating and ventilating systems and has seating accommodation for 370 persons. Films illustrating life and industries in the various countries of the Empire are shown daily at 10.15, 11.35, 2.15 and 3.35 (Sundays 2.45 and 4.15). Special arrangements are made for visits of organised parties from schools and educational institutions. Lectures on industries and countries of the Empire are frequently given in addition to the ordinary cinema displays.

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REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

MANGROVE BARKS FROM TANGANYIKA

THE four samples of mangrove bark which are the subject of this report were forwarded to the Imperial Institute by the Conservator of Forests in September 1934.

The barks had been collected in the Rufiji Delta, and were submitted for examination in order that their relative quality as tanning materials and their suitability for export might be determined. They were as follows :

Number.	Local name.	Botanical name.
152 A	Mlilana	*Sonneratia caseolaris*
153 B	Mshinzi	*Bruguiera gymnorrhiza*
154 C	Mkandaa	*Ceriops Candolleana*
155 D	Mkaka	*Rhizophora mucronata*

All four samples were in the form of irregular pieces of bark varying from about 1 to 4 in. in length and from ¾ to 1½ in. in width.

152 *A. Mlilana* (*Sonneratia caseolaris*).—Rather smooth pieces of bark possessing a laminated structure, and varying from ⅛ to ¼ in. in thickness. The bark was generally pinkish-brown, but in some cases the inner bark was of a somewhat darker colour than the outer. The material disintegrated fairly readily into the thin layers of which it was composed, and broke with a short brittle fracture.

153 *B. Mshinzi* (*Bruguiera gymnorrhiza*).—Irregular pieces of bark varying from ¼ to ⅜ in. in thickness. Both the outer and inner surfaces were rather rough, and dark reddish-brown. The material had a somewhat fibrous appearance, but broke with a short and rather brittle fracture.

154 *C. Mkandaa (Ceriops Candolleana).*—Irregular pieces of bark varying from $\frac{1}{4}$ to $\frac{3}{8}$ in. in thickness, with a laminated structure and a short and brittle fracture. The bark was dark reddish-brown, but not so red as Sample 153 B.

155 *D. Mkaka (Rhizophora mucronata).* Irregular pieces of bark varying from $\frac{3}{8}$ to $\frac{1}{2}$ in. in thickness. The bark, which resembled Sample 154 C in colour, was hard, dense and had a short fracture.

Samples representative of the bulk of each material were withdrawn, and examined with the results given in the following table:

	152 A. *Sonneratia caseolaris.* *Per cent.*	153 B. *Bruguiera gymnorrhiza.* *Per cent.*	154 C. *Ceriops Candolleana.* *Per cent.*	155 D. *Rhizophora mucronata.* *Per cent.*
Moisture	12·0	13·6	12·3	14·8
Insoluble matter	67·5	32·5	51·6	37·8
Extractive matter (non-tannin)	10·6	10·9	11·5	10·4
Tannin [1]	9·9	43·0	24·6	37·0
Ash	4·1	4·5	4·5	5·5
Tintometer readings: [2]				
Red	13·0	11·6	10·5	16·1
Yellow	25·7	20·9	21·1	22·6

[1] *Analyses carried out in accordance with the Official International Method of Tannin Analysis, employing the Proctor method of extraction, Reiss method of filtration and Hide Powder Batch C4.*

[2] *Determined for a solution containing 0·5 per cent. of tannin in a 1 cm. cell.*

Small samples of leather were prepared with each of the barks, the character of the products being as follows:

152 *A. Sonneratia caseolaris.*—Fairly plump, firm, buff-coloured leather.

153 *B. Bruguiera gymnorrhiza.*—Plump, rather hard leather, reddish-brown.

154 *C. Ceriops Candolleana.*—Not quite so plump as the leather yielded by Sample 152 A, but otherwise of similar character, light reddish-brown.

155 *D. Rhizophora mucronata.*—Fairly plump, firm leather, reddish-brown. Grain rather drawn.

Samples of the three barks 153 B (*Bruguiera gymnorrhiza*), 154 C (*Ceriops Candolleana*) and 155 D (*Rhizophora mucronata*) were submitted to merchants in London, who were asked for their opinion as to the quality of the

materials and also regarding the differences from a commercial standpoint between "fibrous" and "non-fibrous" barks. The firm reported as follows:

"We have examined these barks and so far as the Continent and this country are concerned the only quality in which our clients would be interested would be the *Rhizophora mucronata*, as this is definitely the non-fibrous quality.

"At the present time there is a big demand for this quality of bark, and if your friends can offer we would suggest that they communicate direct with us, as we could, no doubt, do a fair amount of business with them.

"In America the liquid extract manufacturers prefer the fibrous quality, and therefore the *Bruguiera gymnorrhiza* quality would be more suitable for them. Apparently their preference for this quality is on account of the low ash contents as compared with the non-fibrous quality, and we believe the fibrous quality is much easier ground than the non-fibrous.

"Of course America is also interested in the non-fibrous bark, and for your guidance we believe we could secure business to-day in America at the price of £6 per ton c.i.f. New York or Philadelphia, the same price applying to both non-fibrous and fibrous bark."

The firm stated that the *Ceriops Candolleana* bark contains too little tannin (24·6 per cent.) to be worth consideration for export.

The results of this investigation show that only two of the barks, viz. Mshinzi (*Bruguiera gymnorrhiza*) and Mkaka (*Rhizophora mucronata*) contained sufficient tannin to render them of interest for export. Previous analyses of the barks of these two species from Tanganyika by German investigators show percentages of tannin generally similar to those found in the present case, although up to as much as 53 per cent. of tannin was recorded for *B. gymnorrhiza* and up to 48 per cent. for *R. mucronata*. It is understood that during the German occupation the bark selected for export did not contain less than 45 per cent. of tannin.

It will be seen from the trade report that only the *R. mucronata* bark, owing to its "non-fibrous" quality,

would be saleable in the United Kingdom or Europe, but that both this bark and the more fibrous bark of *B. gymnorrhiza* could be disposed of in the United States.

The amount of tannin in the present sample of Mkandaa (*Ceriops Candolleana*) is rather low, but recorded analyses show that the bark of *C. Candolleana* generally contains less tannin than the barks of the two above-mentioned species. Bark containing less than 30 per cent. of tannin would not be worth exporting, but material of the quality of the sample would be quite suitable for the local production of solid mangrove extract (or "cutch") for shipment. This enterprise, however, would involve the installation of special extraction and vacuum evaporating plant in Tanganyika.

The Mlilana bark (*Sonneratia caseolaris*) is a very inferior material compared with the other three species. Bark of the present quality would not be worth shipment, and in view of the high proportion of soluble non-tannin matter to tannin, it would also be unsuitable for extract-making. The leather produced with this bark was, however, superior to that yielded by the other samples, being of better colour and lacking the typical red shade of ordinary mangrove-tanned leather; it more resembled the leather obtained with wattle bark.

ARTICLES

EMPIRE FIBRES FOR MARINE CORDAGE

The possibility of employing Empire fibres as substitutes for Manila hemp for the manufacture of marine cordage has been the subject of investigation by the Admiralty and the Imperial Institute for the past ten years. The work has been carried out in co-operation with the Institute's Advisory Committee on Vegetable Fibres, and reports on the various trials already completed have been published in the Bulletin of the Imperial Institute (1927, **25**, 359; 1931, **29**, 1; 1932, **30**, 119; 1933, **31**, 30 and 500). As a result of these tests the Admiralty have arranged for the partial adoption in the Service of

ropes made of East African Sisal and New Zealand hemp (Phormium fibre) in place of Manila ropes.

In continuation of the experiments, the Admiralty have now investigated the effect of tarring on the durability of Sisal cordage. The results are recorded in the following report, which has been kindly furnished to the Imperial Institute and is now published for general information.

Tests of Tarred and Untarred Cordage made from East African Sisal

Report of Exposure Tests carried out by the Admiralty, 1933–34

1. All Sisal for Admiralty requirements is at present used in the condition in which it is received. This is in accordance with the practice followed in the case of Manila.

In order to ascertain the capacity of Sisal to absorb tar and whether cordage so treated would have its weather-resisting properties increased, the Admiralty decided to treat with tar a small portion of Sisal and to carry out exposure tests in comparison with similar Sisal cordage untarred.

2. To carry out the tests, four 120-fathom coils of 3-inch cordage were manufactured. All the yarn used for this purpose was from the same delivery of No. 1 East African Sisal. Two of these coils were tarred and two were untarred.

The two tarred coils were prepared in the usual manner, i.e. the yarn was passed through a bath containing Archangel tar. The quantity of tar absorbed by the fibre was 12·87 per cent. of the weight of the finished coil. During the process of manufacture a batching compound was used, about 4½ per cent. being used for dressing the fibre which was subsequently tarred, and 12½ per cent. in the case of the untarred fibre.

3. The cordage was manufactured in the Dockyard Ropery at Devonport and the exposure tests were also carried out at Devonport. The method of manufacture was in accordance with Government Department Specification T.G.30, viz.:

Circumference	3 in.
Number of strands	3
Size of yarn	30-thread
Number of yarns in each strand . . .	30
Angle of lay	39°

4. The conditions of the exposure tests were as follows:

Two of the coils (one untarred and one tarred), were subdivided into 60-fathom lengths, and one length of each was exposed to the action of sea-water in such a manner that each was completely submerged at high tide and completely exposed at low tide. The remaining 60-fathom lengths were allowed to lie on the Ropery floor under normal storage conditions.

The other two coils (one untarred and one tarred) were opened out and exposed to the weather conditions on the Ropery roof.

5. The dates of manufacture and testing were as follows:

Tarring	December 8, 1933
Manufacture into cordage . . .	December 9, 1933
Initial tensile tests	December 12, 1933
Commencement of exposure tests . .	January 8, 1934
Completion of exposure tests . . .	October 8, 1934

6. Tensile tests were carried out immediately after manufacture. Sections were also removed from each sample at the end of two, four, six and nine months' exposure and subjected to tensile tests. The test pieces in all cases were washed in fresh water and tested in an air-dry condition on a Denison 30-ton Cordage Testing Machine, the length between the grips being 6 ft.

7. The standard breaking strain for 3-in. Manila and Sisal Cordage is 8,960 lb. (80 cwts.). In conformity with the standard which obtains in the case of tarred and untarred Italian cordage, a much lower breaking strain is accepted for the tarred than for the untarred. In accordance with the Government Departmental Specification for Italian cordage the variation for 3-in. cordage is as follows:

Untarred	84 cwts.	Reduction
Tarred	70 cwts.	$16\frac{2}{3}$ per cent.

On this basis the standard breaking strain for tarred Sisal can be assumed to be about 7,400 lb.

8. In all cases six tensile tests were carried out, and the average results obtained during the whole period of the trials can be compared as follows :

BREAKING STRAIN, UNTARRED ROPE

—	Standard.	Before Exposure.	After Exposure for Two months.	Four months.	Six months.	Nine months.	Total percentage reduction.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	
	8,960	10,827					
(*a*) Exposed to sea			9,109	8,493	5,338	2,595	76
(*b*) Exposed on roof . .			10,733	10,360	9,632	9,464	13
(*c*) Under storage conditions .			11,032	10,416	10,118	10,360†	4

BREAKING STRAIN, TARRED ROPE

—	Standard.	Before Exposure.	After Exposure for Two months.	Four months.	Six months.	Nine months.	Total percentage reduction.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*	
	7,400[1]	9,837					
(*a*) Exposed to sea			9,221	9,109	8,176	7,019	29
(*b*) Exposed on roof . .			9,669	9,240	8,082	8,717†	11
(*c*) Under storage conditions .			9,613	9,352	8,288	9,240†	6

[1] *See paragraph* 7.

In three cases (marked †) the results at the end of nine months were in excess of those obtained at the end of the six-month period. No definite reason can be assigned for this variation, except that in the case of cordage such variations are not unusual. The six-month tests were carried out in July after a prolonged spell of dry, warm weather, whereas the nine-month tests were made in October after a spell of rainy weather, and this probably influenced the results.

Details of these tests are given in the following tables. For a closer appreciation of the tensile results graphs showing the variations over the nine-month period are reproduced on pages 10 and 11.

BREAKING STRAIN OF THE ROPES BEFORE EXPOSURE

(December 12, 1933)

	UNTARRED (Standard 8,960).	TARRED (Standard 7,400).
	lb.	lb.
Test 1 .	10,752	10,080
,, 2 .	11,200	9,632
,, 3 .	10,976	9,520
,, 4 .	10,752	10,080
,, 5 .	10,304	9,856
,, 6 .	10,976	9,856
Maximum .	11,200	10,080
Minimum .	10,304	9,520
Variation .	896	560
Average .	10,827	9,837

BREAKING STRAIN AFTER TWO MONTHS' EXPOSURE

(January 8 to March 8, 1934)

	UNTARRED (Standard 8,960).			TARRED (Standard 7,400).		
	Sea Exposure.	Roof Exposure.	Storage Conditions.	Sea Exposure.	Roof Exposure.	Storage Conditions.
	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	9,184	10,864	11,200	8,960	10,304	9,408
,, 2 . .	8,736	11,200	10,864	9,184	9,856	9,632
,, 3 . .	9,744	10,640	10,752	8,960	9,520	8,960
,, 4 . .	8,960	10,752	11,200	9,632	9,856	9,520
,, 5 . .	9,072	10,192	10,752	8,848	9,632	9,856
,, 6 . .	8,960	10,752	11,424	9,744	8,848	10,304
Maximum . .	9,744	11,200	11,424	9,744	10,304	10,304
Minimum . .	8,736	10,192	10,752	8,848	8,848	8,960
Variation . .	1,008	1,008	672	896	1,456	1,344
Average . .	9,109	10,733	11,032	9,221	9,669	9,613

BREAKING STRAIN AFTER FOUR MONTHS' EXPOSURE

(January 8 to May 8, 1934)

	UNTARRED (Standard 8,960).			TARRED (Standard 7,400).		
	Sea Exposure.	Roof Exposure.	Storage Conditions.	Sea Exposure.	Roof Exposure.	Storage Conditions.
	lb.	lb.	lb.	lb.	lb.	lb.
Test 1 . .	7,840	11,200	10,752	9,296	8,512	9,408
,, 2 . .	9,072	10,192	10,640	8,736	8,960	8,624
,, 3 . .	9,072	10,080	10,528	8,736	9,632	9,408
,, 4 . .	7,616	10,080	10,192	9,968	8,960	9,520
,, 5 . .	8,064	10,752	9,744	9,184	9,520	9,520
,, 6 . .	9,296	9,856	10,640	8,736	9,856	9,632
Maximum . .	9,296	11,200	10,752	9,968	9,856	9,632
Minimum . .	7,616	9,856	9,744	8,736	8,512	8,624
Variation . .	1,680	1,344	1,008	1,232	1,344	1,008
Average . .	8,493	10,360	10,416	9,109	9,240	9,352

BREAKING STRAIN AFTER SIX MONTHS' EXPOSURE

(January 8 to July 8, 1934)

—	UNTARRED (Standard 8,960).			TARRED (Standard 7,400).		
	Sea Exposure.	Roof Exposure.	Storage Conditions.	Sea Exposure.	Roof Exposure.	Storage Conditions.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Test 1 . .	4,704	9,520	10,304	8,512	7,840	8,512
,, 2 . .	4,592	10,528	9,968	7,616	7,952	8,624
,, 3 . .	5,824	8,848	9,856	8,400	8,288	8,176
,, 4 . .	5,824	10,192	9,744	8,400	8,736	8,176
,, 5 . .	5,264	9,072	10,528	8,064	7,840	8,176
,, 6 . .	5,824	9,632	10,304	8,064	7,840	8,064
Maximum . .	5,824	10,528	10,528	8,512	8,736	8,624
Minimum . .	4,592	8,848	9,744	7,616	7,840	8,064
Variation . .	1,232	1,680	784	896	896	560
Average . .	5,338	9,632	10,118	8,176	8,082	8,288

BREAKING STRAIN AFTER NINE MONTHS' EXPOSURE

(January 8 to October 8, 1934)

—	UNTARRED (Standard 8,960).			TARRED (Standard 7,400).		
	Sea Exposure.	Roof Exposure.	Storage Conditions.	Sea Exposure.	Roof Exposure.	Storage Conditions.
	lb.	*lb.*	*lb.*	*lb.*	*lb.*	*lb.*
Test 1 . .	2,576	9,296	9,856	6,944	8,400	9,744
,, 2 . .	2,240	9,856	10,080	6,944	9,408	9,408
,, 3 . .	2,912	9,632	10,304	6,944	9,072	9,184
,, 4 . .	2,576	9,408	10,640	7,056	8,960	8,736
,, 5 . .	2,576	9,184	10,976	7,056	8,624	9,184
,, 6 . .	2,688	9,408	10,304	7,168	7,840	9,184
Maximum . .	2,912	9,856	10,976	7,168	9,408	9,744
Minimum . .	2,240	9,184	9,856	6,944	7,840	8,736
Variation . .	672	672	1,120	224	1,568	1,008
Average . .	2,595	9,464	10,360	7,019	8,717	9,240

9. For the full nine months' exposure the tensile results can be summarised as follows:

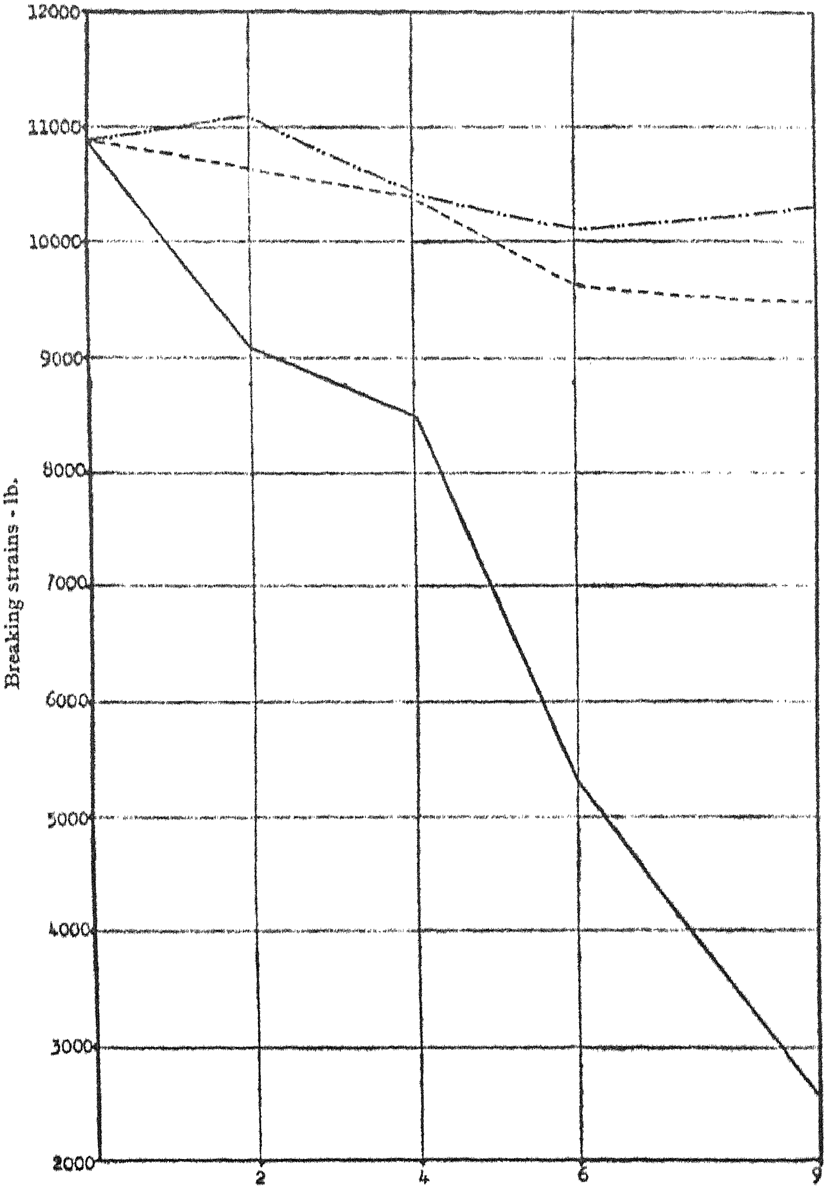
—	Standard.	When New.	Sea Exposed.	Roof Exposed.	Storage Conditions.
White (untarred) . . *lb.*	8,960	10,827	2,595	9,464	10,360
Depreciation. . *per cent.*			76	13	4
Tarred . . . . *lb.*	7,400	9,937	7,019	8,717	9,240
Depreciation. . *per cent.*			29	11	6

In the case of the cordage under storage and roof-exposed conditions the results at the end of the nine months' period are still considerably in advance of the standard laid down for new cordage.

3-IN. SISAL CORDAGE

UNTARRED

Breaking strains obtained from samples after manufacture and during exposure tests.



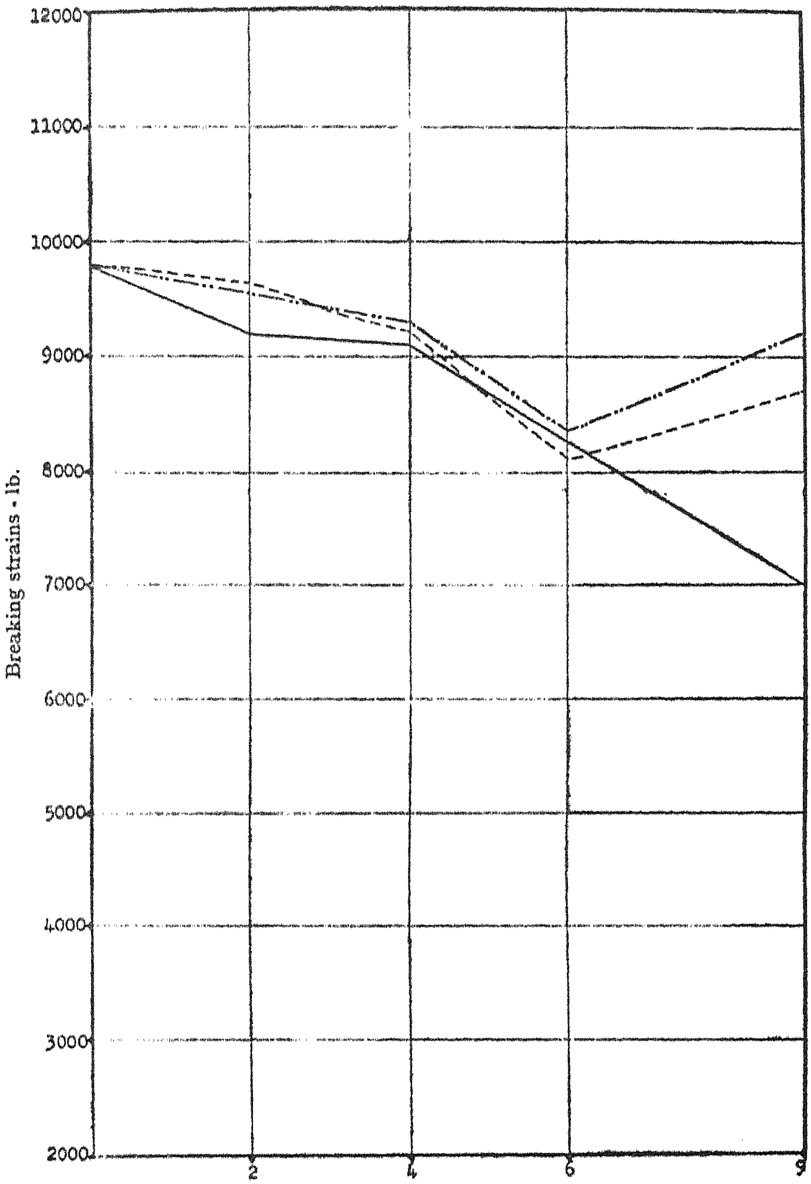
Sea exposed ——— Roof exposed ----- Storage conditions —··—

Standard breaking strain for 3-in. untarred cordage 8,960 lb.

3-IN. SISAL CORDAGE

TARRED

Breaking strains obtained from samples after manufacture and during exposure tests.



Sea exposed ——— Roof exposed ------ Storage conditions —·,·—

Standard breaking strain for 3-in. tarred cordage (Italian) 7,400 lb.

10. Similar sea-exposure tests with 3-in. Sisal and Manila cordage have been carried out both by the Admiralty and Imperial Institute. In each case these were untarred. The results of the present series with previous tests may be compared as follows :

Sea Exposed.	Before Immersion.	After Exposure for				Percentage total loss.
		Two months.	Four months.	Six months.	Nine months.	
	lb.	lb.	lb.	lb.	lb.	
Present Series						
Untarred Sisal . .	10,827	9,100	8,493	5,338	2,595	76
Tarred Sisal . . .	9,837	9,221	9,109	8,170	7,019	29
Imperial Institute Series (As reported in this BULLETIN, 1932, **30**, 119)						
Untarred Sisal . .	9,035	7,107	4,377	3,775	3,042	66
Untarred Manila (S. 3) .	11,407	10,507	5,705	4,008	3,070	73
,, ,, (K) .	11,187	9,210	5,158	4,190	2,853	74
,, ,, (M. 1) .	10,433	9,205	4,842	3,678	2,836	73
Admiralty Lists, 1927–28						
Untarred Sisal . .	9,333	6,216	5,189	4,356	2,987	68
Untarred Manila (J) .	9,146	7,046	6,132	5,311	4,181	54

11. *Oscillometer tests.*—In order to compare the resistance of Sisal and Manila to abrasion, oscillometer tests have been in progress over a considerable period at Devonport, and the oscillations obtained from untarred Sisal and Manila before breaking compare as follows :

Sisal : 36,608, 37,596, 38,366, 20,432, 34,407. Average, 33,480.

Manila : 9,311, 7,384, 7,315, 7,410, 6,085. Average, 7,681.

Oscillometer tests were also carried out with the Sisal tarred cordage with the following results :

2,931, 2,324, 1,929, 1,905, 2,095. Average, 2,237.

A comparable test made with Italian tarred cordage broke after 812 oscillations. The whole of the foregoing oscillometer tests were made while loaded with weights of 561 and 182 lb. Further tests carried out with Italian tarred under less strenuous conditions with loads of 411 and 130 lb. gave the following results :

2,931, 1,427, 1,381, 1,028, 1,158. Average, 1,575.

The tarred Sisal therefore gave results almost 50 per cent. better than Italian tarred.

The oscillometer test is hardly applicable to tarred cordage, as owing to its heavy loading and the high rate of oscillation, the tarred yarn quickly overheats. The oscillometer conditions also are not comparable with the ordinary Service conditions; it has been used, however, to give some measure of comparison of the resistance of fibre to abrasion.

12. *Yarn tests.*—The initial strength of the untarred yarn before manufacture into cordage was 175·4 lb. and 163·6 lb. for the tarred. Strands removed from the cordage at the end of the nine months' period gave the following results (average of ten tests).

—	Sea Exposed.	Roof Exposed.	Storage Conditions.
	lb.	*lb.*	*lb.*
Untarred	72	95	161·0
Tarred	132·5	139·5	150·5

13. *Circumference.*—The actual circumference after manufacture was 3 in. in each case. The maximum size recorded during the tests of the sea-exposed cordage was 3¼ in. and the roof-exposed 3⅛ in.

14. *Recommendations.*—It is considered the results of these tests warrant consideration of the general adoption of tarred Sisal cordage in lieu of tarred hemp cordage, and enquiries are now being made as to the extent to which such substitution can be carried out.

It is also under consideration to carry out trials under service conditions in the Fleet both at home and abroad to ascertain whether tarred Sisal cordage can be regarded as suitable for boats' falls.

CINCHONA IN AMANI

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CONTENTS

1. Introduction

Owing to the continued interest shown in the Amani cinchona plantations, it has been decided to bring together in one paper all the available information on the subject since cinchona was first sown in Amani in 1902.

Most of the facts have been obtained from the various files in Amani, both German and British, and have not previously been published.

2. Historical

The history of quinine in Amani dates back to the foundation of the Institute. The German Government approved of the opening of the Biologisch-Landwirtschaftliches Institut in Amani on June 4, 1902, and that the authorities were alive to the possibilities of cinchona cultivation in the Usambara district is evidenced by the fact that a few grams of seed of hybrid cinchona (*Ledgeriana* × *succirubra*), of known high quinine content, were received from Java on August 14, 1902.

These seeds were immediately sown and were ready for transplanting to freshly cleared land on Bomole, a hill of 3,200 to 3,700 ft. altitude in Amani, by February 1903. Further supplies of seed were obtained from Java, the

German reports giving the following details of receipts: on February 11, 1903, 25 g. of hybrid and 50 g. of *C. Ledgeriana*; in December 1903 sufficient seed to produce 10,000 seedlings of *C. succirubra*; during 1904 sufficient for 5,000 *C. robusta* seedlings.

It should be mentioned that cinchona seeds are very light in weight, 1 gram containing about 2,300 and 1 ounce about 65,000.

The records show that by March 1906 there were 6,587 *C. Ledgeriana*, 9,049 *C. succirubra*, 3,658 *hybrid* and 2,700 *C. robusta* trees in the plantations.

By March 1906 the original hybrid trees from the first few grams of seed were sufficiently developed for samples of the bark to be sent to Germany for analysis. The quinine content was found to be equivalent to 6·58 per cent. sulphate, which was a satisfactory result for four-year-old trees.

In 1909, a shipment of 403 kilos. of hybrid bark realised 232 marks (= £11 12*s.*) in Germany; this bark contained 5·5 per cent. quinine, expressed as sulphate.

In 1912, 3,000 kilos. of *C. succirubra* bark realised 1,330 marks (= £66 10*s.*), and in 1913 a total of 3,566 kilos. of various barks realised 5,003 marks (= £250).

When the war started in 1914 the resources of Amani were utilised for the German campaign in East Africa and there was, of course, a big demand for quinine. Later reports show that the total amount of quinine produced in Amani up to the end of March 1916 was represented by 300 lb. of pure quinine sulphate and 13 lb. of impure quinine; in addition 130 loads (about 8,000 lb.) of bark were sent to Mpwapwa for the making of febrifuge.

General von Lettow-Vorbeck, the commander of the German troops in East Africa, states in his book on the East African campaign (Ref. 1) that not only was sufficient quinine manufactured in Amani for the full needs of their troops in Tanganyika, but also they were enabled to send a quantity to Germany to make up for the shortage there.

It is thus evident that the Amani cinchona plantations played an important part in the East African campaign.

After the British occupation, interest in cinchona cultivation was continued, and in 1918 samples of the

several barks from Amani were forwarded to the Imperial Institute and were very favourably reported on.

Mr. Leechman, the first British Director in Amani, at once realised the value of these plantations, and the existing correspondence shows that he several times urged the local government to carry on with cinchona cultivation. One letter shows that he suggested that the Derema Estate, which adjoins Amani, and was then for sale as ex-enemy property, should be reserved by Government for the laying-out of new cinchona plantations. At that period the Amani Station was on a bare maintenance basis with no European staff except the Director, and no steps were taken in the matter.

All the cinchona trees had been cut down by the Germans during the war, but by 1919 the ratoons had grown sufficiently for a considerable harvest of bark to be gathered. The reports available show that 16,500 lb. were shipped, but no record of the price realised can be found ; if, however, it is taken at the average figure of 1*s.* a pound, the value of these shipments was £825 (this is probably a low estimate).[1]

In subsequent years Mr. Leechman shipped to the United Kingdom in all 14,700 lb. of bark for which a total of £955 was paid.

Meanwhile, a large amount of seed had been sown, and in 1921 the nursery contained 6,532 *C. Ledgeriana* seedlings and 4,801 hybrid seedlings. These were subsequently planted over an area of 5½ acres of the Drachenberg Plantation, at an altitude of 2,750 to 2,850 ft.

In 1923 the Institute was practically closed down and no further work was carried out on cinchona until after the revival of Amani under the present Director, when the subject soon came to the fore again.

In December 1925 the Committee of Civil Research had appointed a sub-committee to enquire into the

[1] It may be mentioned that a consignment of Amani cinchona bark was forwarded to the Imperial Institute in August 1919 and the results of its examination and sale were recorded in the BULLETIN OF THE IMPERIAL INSTITUTE, Vol. XVIII (1920), No. 1, p. 22. The consignment consisted of 6,860 lb. of chip bark apparently derived from *C. succirubra* and 60 lb. of quill bark of the *C. Ledgeriana* type ; the prices realised were 5½*d.* per lb. for the chips and 11*d.* per lb. for the quills. [ED.]

question of Empire supplies of quinine. The sub-committee in July 1926 submitted their recommendations, which in brief were as follows: (1) any general scheme for the extension of cinchona cultivation in the Empire would be premature pending the receipt of further information on the synthetic product, beprochin; (2) whatever the value of synthetic products it will probably be necessary to create new plantations if the Empire is to be self-supporting in quinine and cinchona alkaloids; (3) as a first step a grant of £2,000 a year for ten years should be made to Amani to enable it to restore and extend its plantations and to carry out experimental work; (4) the recommendations should be submitted for the favourable consideration of the Empire Marketing Board.

With reference to the first recommendation, a sub-committee was appointed to report on the value of beprochin.

A comprehensive report on the state of cinchona cultivation at Amani, including determinations of the alkaloid content of the various types of bark, was submitted by the Director to the Secretary of State early in 1930, and the matter was discussed further during the Director's leave. No action was decided upon, owing, as it appeared, to the expectations aroused by experiments with synthetic drugs.

In 1931 the conference of East African Directors of Agriculture held at Amani recommended that the question of cinchona cultivation and anti-malarial measures should be reconsidered by the Colonial Office. A sub-committee of the Colonial Advisory Council of Agriculture and Animal Health was formed, and they reported against any special work on cinchona, their views being very briefly: (1) that the most important avenue to explore was the production of synthetic products, which held out a high promise of sufficient production and cheapness to replace quinine; (2) there was reason to expect soon drugs better than quinine, the higher efficacy of which might counterbalance any increase in cost; (3) the cost of quinine production in East Africa was unlikely to be lower than in Java; (4) the efficacy of the mixed alkaloids was doubtful and unstandardised as compared with quinine. The main

cost of anti-malarial treatment was in the distribution of the drugs and the Committee doubted if this treatment could be advanced by producing large quantities of mixed alkaloids without additional facilities for their distribution.

As a result of this report all research work on cinchona in Amani ceased. The synthetic products, however, are still far from replacing quinine, their cost being relatively high for general anti-malarial work amongst natives; and the Medical Departments are again considering the use of cinchona febrifuges.

In 1932 and 1933 all the cinchona trees in Amani, with the exception of a plot of *C. Ledgeriana* kept for seed, were cut down and their bark stripped and shipped to England for sale; the trees in the Drachenberg Plantation were thus cut for the first time, whilst those on Bomole were cut for the third or fourth time. All are coppicing again well.

The total yield of all barks was 34,961 lb., and this sold for £1,679 6*s*. 9*d*., or an average of 11·24*d*. per lb.

A calculation of the total proceeds from the sale of cinchona bark in Amani since it was planted up to the present day gives (and the records of sales are probably incomplete) a total of about £3,700; if to this is added a sum calculated for the value of bark employed during the war, assuming 1*s*. per lb., we get a total of about £4,500. This sum is, of course, not profit, since no costs of production have been deducted, but it would be safe to say that the Amani cinchona has produced at least £3,000 profit for the Institute.

3. Quality of the Bark

(*a*) *Hybrid cinchona* (*Ledgeriana* × *succirubra*)

This was the first cinchona to be planted in Amani, from selected Java seed, and the first to be analysed; in 1906 a sample was sent to Germany and proved to contain 4·84 per cent. quinine, equivalent to 6·48 per cent. quinine sulphate, and 6·77 per cent. total alkaloids. This was an encouraging result for four-year-old trees, as alkaloid content does not usually reach its maximum until the eighth year.

In 1908 a shipment to Germany contained an average of only 5·5 per cent. quinine, as sulphate, a figure which seems abnormally low in view of the fact that in 1914 the same group of trees contained 5·97 per cent. quinine, or 8·00 per cent. quinine sulphate. These trees were then ten to eleven years old and the quinine content should have reached its maximum two to three years back, according to various authorities.

After being cut down during the war, regrowth occurred, and in 1918 samples of bark from these ratoons were sent to the Imperial Institute, when 8·41 per cent. of quinine (= 11·21 per cent. quinine sulphate), and 11·30 per cent. total alkaloids were found. The bark was described as being equal to the finest Ledger bark from Java as regards quinine content.

After being cut down again in 1921, samples were taken from the new ratoons from three selected trees and sent for analysis, the result of which was 6·97, 5·45 and 6·77 per cent. quinine (= 9·48, 7·41 and 9·20 per cent. quinine sulphate), and 10·20, 10·26 and 11·83 per cent. total alkaloids. Thus the quinine content was beginning to fall, from 8·41 to 6·4 per cent. (average), although the total alkaloids remained constant.

No further work was done on the hybrid trees until 1929, when the present author took three samples, of several trees in each case, and found 5·80, 5·84 and 6·15 per cent. quinine and 8·19, 8·44 and 8·94 per cent. total alkaloids. When the trees were harvested in 1933 and the bark shipped home for sale, a sample analysed in Amani showed 4·29 per cent. quinine and 7·10 per cent. total alkaloids, whilst the average of analyses made by the brokers on different shipments showed 3·95 per cent. quinine and 7·41 per cent. total alkaloids.

It is thus evident that these trees, now thirty years old, are well past their maximum alkaloid content, which occurred when they were about fourteen years old, but they are still likely to be of commercial value for some years to come.

In the meantime new trees planted from seed of the above in 1922 were ready for harvesting in 1929 to 1930. At this date the author found them to contain only (1)

3·5 per cent., (2) 3·03 per cent. quinine; and (1) 5·43 per cent., (2) 5·70 per cent. total alkaloids, thus showing that they had reverted to a considerable extent to *C. succirubra*. When they were cut down in 1933 and shipped to England, the average figure from the brokers was 3·05 per cent. quinine and 6·68 per cent. total alkaloids.

These results indicate that the hybrid must be grown from seed of the first cross between Ledger and succirubra trees and not from its own seed.

Table 1 shows the collected results for these trees.

TABLE 1

Alkaloid Content of Amani Hybrid Cinchona

Trees.	Year.	Quinine.	Quinine Sulphate.	Cinchonine.	Cinchonidine.	Amorphous.	Total.	Remarks.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Original, planted 1902	1906	4·84	6·48	—	—	—	6·77	Ref. 2
	1914	5·97	8·00	—	—	—	—	Ref. 3
	1914	6·05	8·10	—	—	—	—	
Original, Ratoons	1918	8·41	11·21	—	nil	—	11·30	Ref. 4
do. do.	1921	6·97	9·48	—	0·62	—	10·20	Ref. 5
do. do.	1921	5·45	7·41	—	2·70	—	10·26	
do. do.	1921	6·77	9·20	—	0·73	—	11·83	
do. do.	1930	5·80	7·75	nil	nil	2·39	8·19	Author's results
do. do.	1930	5·84	7·80	0·90	nil	1·70	8·44	
do. do.	1930	6·15	8·31	1·26	0·14	1·39	8·94	
do. do.	1933	4·29	5·74	—	—	—	7·10	Author's results
do. do.	1933	4·45	5·96	—	0·49	—	8·18	Broker's report
do. do.	1933	3·12	4·20	—	0·68	—	6·40	
do. do.	1933	4·29	5·75	—	0·71	—	7·05	
Seedlings, planted 1922	1930	3·55	4·78	0·73	0·05	1·10	5·43	Author's results
	1930	3·03	4·07	0·98	0·17	1·61	5·79	
	1933	3·23	4·33	—	0·84	—	7·28	Broker's report
	1933	2·87	3·85	—	0·55	—	6·00	

(b) *Cinchona Ledgeriana*

This cinchona, also from selected Java seed, was planted in 1903, but the first analysis on record was in 1913, when a shipment of the bark was made to Germany; 10·55 per cent. quinine, as sulphate, was found in these ten-year-old trees. This was a very good yield and has not since been equalled by any Ledger trees in Amani.

After being cut down during the war the Ledger trees, which are less hardy than the other species, made poor growth in many cases and analysis of these ratoons in 1918 showed only 5·08 per cent. quinine, as sulphate.

All these trees were stripped of bark between 1918 and 1922, and in 1930 they showed only 4·2 per cent. quinine, as sulphate. In 1933 the brokers reported an average value of 6·44 per cent. quinine, as sulphate, on the whole yield of this bark.

Meanwhile, the new trees, from seed of the above, planted in 1922 were found in 1930 to give high yields of quinine: three samples analysed in Amani giving 10·00, 9·01 and 9·81 per cent. quinine, as sulphate. When these trees were cut down in 1933 the London brokers reported an average content of 9·84 per cent. quinine, as sulphate.

It will be of great interest to see, in a few years' time, if these trees also show a big drop in alkaloid content. The soil of the Drachenberg Plantation, where they are, is far better than that on Bomole, and the new shoots appear to be quite vigorous and healthy.

Table 2 shows the collected results.

TABLE 2

Alkaloid Content of Amani Cinchona Ledgeriana

Trees.	Year.	Quinine.	Quinine Sulphate.	Cinchonidine.	Amorphous.	Total.	Remarks.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Original . .	1913	7·71	10·55	—	—	—	Ref. 3
Original, Ratoons	1918	3·81	5·08	nil	—	5·00	Ref. 4
do. do.	1930	3·04	4·13	0·21	1·56	4·81	Author's results
do. do.	1930	3·21	4·36	0·17	1·62	5·00	
do. do.	1933	4·76	6·40	0·34	—	6·99	Broker's report
do. do.	1933	4·82	6·48	0·34	—	6·77	
Seedlings, planted 1922	1930	7·44	10·00	0·42	1·70	9·14	Author's results
	1930	6·68	9·01	0·44	2·05	9·17	
	1930	7·26	9·81	0·35	1·62	9·19	
	1933	7·34	9·84	0·27	—	8·92	Broker's report
Indian, average .	—	5·49	7·45	—	—	8·52	Cowan
Java, average .	—	8·0	10·7	—	—	—	

(*c*) *Cinchona succirubra*

These trees were likewise planted in 1903 from Java seed, and the first analysis on record was in 1912, when the bark was found to contain 3·07 per cent. quinine, as sulphate. A quantity of 3,000 kilos. of this bark was shipped to Germany, but it only realised 5¼*d.* a kilo. (under 2½*d.* per lb.). This was evidently too low a price, since this variety was not shipped to Germany again for sale.

However, it found ready use during the war and was harvested along with the other varieties.

The ratoons in 1918 showed very little difference in yield of alkaloids, giving 3·39 per cent. quinine, as sulphate.

By 1930, after at least one more stripping of bark, the content had fallen to 2·7 per cent. quinine, as sulphate, and in 1933, when these trees were harvested, the brokers found an average of only 2·11 per cent. quinine, as sulphate.

On account of the low quinine content of this species no new trees were planted out in 1922.

Table 3 gives the collected results.

TABLE 3

Alkaloid Content of Amani Cinchona succirubra

Trees.	Year.	Quinine.	Quinine Sulphate.	Cinchonidine.	Cinchonine.	Quinidine.	Amorphous.	Total.	Remarks.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Original . .	1912	2·29	3·07	—	—	—	—	—	Ref. 3
Original, Ratoons	1918	2·54	3·39	2·05	—	—	—	8·32	Ref. 4
do. do.	1930	2·05	2·75	1·47	1·41	0·11	1·25	6·29	Author's results
do. do.	1930	1·96	2·63	1·45	1·41	0·09	1·18	6·09	
do. do.	1933	—	1·66	1·52	—	—	—	6·83	Broker's report
do. do.	1933	—	2·18	1·35	—	—	—	6·27	
do. do.	1933	1·91	2·59	1·59	—	—	—	7·24	
Indian, average	—	1·40	1·91	—	—	—	—	6·25	Cowan

(*d*) *Cinchona robusta*

A small area of these trees was planted out in 1903 and an analysis in 1913 showed 4·87 per cent. quinine, as sulphate.

In 1918, ratoons showed 3·55 per cent. quinine, as sulphate, and 3·51 per cent. cinchonidine. The large proportion of cinchonidine is the chief factor against this species, as it increases the difficulty of separating the pure quinine.

In 1930 these trees showed only 2·8 per cent. quinine, as sulphate, 2·25 per cent. cinchonidine and only 5·8 per cent. total alkaloids.

No new trees were planted in 1922.

Table 4 shows the collected results.

TABLE 4

Alkaloid Content of Amani Cinchona robusta

Trees.	Year.	Quinine.	Quinine Sulphate.	Cinchonidine.	Cinchonine.	Amorphous.	Total.	Remarks.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	
Original, planted 1903	1913	3·63	4·87	—	—	—	—	Ref. 3
Original, Ratoons	1918	2·66	3·55	3·51	—	—	7·61	Ref. 4
do. do.	1930	2·01	2·73	2·42	0·12	1·31	5·86	Author's results
do. do.	1930	2·12	2·88	2·08	0·14	1·42	5·76	

4. Yield of Bark

The German records do not show how much bark was obtained on the average from each tree. The figures available show that in 1912 and 1913 the following total weights of bark were collected: *C. Ledgeriana*, 1,904 kilos.; *C. succirubra*, 3,000 kilos.; hybrid, 851 kilos.; *C. robusta*, 1,214 kilos. The records show that in 1906 the number of trees of each variety was 6,587, 9,049, 3,658 and 2,700 respectively; this would give a yield of 0·64, 0·73, 0·53 and 0·99 lb. per tree. This is a very small yield, but is probably somewhere near the correct value as there is no record of any large number of the trees dying, and as no further bark was collected in the following year it is probable that the whole amount on the trees was harvested at once. The amount of quinine sulphate obtained from this bark was 651 lb.

This yield is borne out to some extent by the war-time yields, when by cutting down all the trees in Amani the Germans obtained 317 lb. of quinine sulphate and 8,000 lb. of bark, which at an average yield of 5·8 per cent. quinine sulphate gives 464 lb., or a total of 781 lb. compared with 651 lb. in 1912–13.

In 1921 the bark obtained from three selected hybrid trees, each 37 ft. high, was (1) 18 in. girth at base, 22 lb. of bark; (2) 22 in. girth, 36 lb.; (3) 23 in. girth, 30 lb. These trees, however, were exceptional, and nothing approaching these yields has been obtained for the average trees.

In 1932–33 the following yields of bark were obtained: 2,833 hybrid trees, eleven years old, gave 6,904 lb. of dried bark, that is 2·44 lb. per tree, and 3,690 trees *C.*

Ledgeriana of the same age gave 3,797 lb. of dried bark or 1·03 lb. per tree. These figures are equivalent to a yield of 2,760 lb., or 24·7 cwts., of hybrid bark per acre, and 1,266 lb., or 11·3 cwts. of Ledger bark per acre. It should be mentioned that after these trees were planted out in 1922 they received no further attention whatever, such as weeding, thinning-out, etc., owing to the almost complete closing-down of Amani; had they received proper care the yields would no doubt have been higher.

At the same time, 1932–33, the ratoons of the old trees planted in 1902–03 yielded as follows: 4,563 *C. Ledgeriana* trees gave 10,023 lb. of bark, i.e. 2·10 lb. per tree; 3,630 *C. succirubra* trees gave 9,051 lb. of bark, or 2·49 lb. per tree; and 1,475 trees consisting of 751 hybrid and 724 *C. robusta* gave 4,472 lb. of bark or 3·03 lb. per tree.

All the results show that *C. Ledgeriana* produces considerably less bark per tree than the other species.

Table 5 gives the various yields so far as they can be computed.

TABLE 5

Yields of Bark in lb. from Cinchona Trees in Amani

Year.	*Ledgeriana.*		*Hybrid.*		*Succirubra.*		*Robusta.*	
	Total.	Per tree.	Total.	Per tree.	Total.	Per tree.	Total.	Per tree.
1912–13	4,180	0·64	1,872	0·53	6,000	0·73	2,671	0·99
1921 (3 selected trees)	...	...	88	29·3		...	...	...
1932–33 (eleven years old)	[1] 3,797	1·03	[2] 6,904	2·44	...			
1932–33 (thirty years old)	10,023	2·19	[3] 4,472	[3] 3·03	9,051	2·49	...	...

[1] = 11·3 *cwts. per acre.*
[2] = 24·7 *cwts. per acre.*
[3] *Equal numbers of hybrid and robusta mixed.*

5. Value of the Bark

Some figures are available in the German records of the price obtained for Amani Cinchona bark. The bark was sold in Germany entirely on quinine content, there being a unit price which was a price per 1 per cent. per kilo. of bark, and although this unit price varied from year to year the grower had a better idea of the value of his crop than with the present system in England whereby the bark

is auctioned, frequently without the quinine content being known, and appearance plays a considerable part in its value.

In 1908, hybrid bark to the amount of 403 kilos. sold for 232·25 M. in Germany ; it contained 5·5 per cent. quinine, as sulphate, and the unit price was 10·478 M. per kilo.

In 1912, *C. succirubra* bark (3,000 kilos.), containing 3·07 per cent. quinine, as sulphate, or a total of 92·376 kilos., with a unit price of 14·4 M., sold for 1,330 M. (about £66 10s.).

In 1913, a large consignment of bark was sent to Germany, the unit price being 16·9 M. Table 6 shows the yields of quinine and the prices realised.

TABLE 6

Bark.	Weight.	Quinine sulphate.		Value.
	Kilos.	*Per cent.*	*Total kilos.*	*Marks.*
Ledgeriana . .	1,904·0	10·55	200·84	3,394·3
Robusta . .	1,214·5	4·87	59·15	999·6
Hybrid . .	231·5	8·0	18·52	313·0
Hybrid . .	216·5	8·1	17·54	296·4
Total . .	3,566·5	—	296·05	5,003·3

No figures are available for the proceeds of the sale of the bark in 1919, but 16,500 lb. were shipped to London, and if the value is put at the conservative one of 1*s*. lb. the bark will have realised £825.[1]

During 1920 further large shipments were made to London ; 3,295 lb. of *C. succirubra* bark at 1*s*. 10*d*. a lb. sold for £302 0*s*. 10*d*. ; 4,065 lb. of *C. robusta* bark at 1*s*. a lb. for £203 5*s*., and 4,985 lb. of C. *Ledgeriana* at 7¾*d*. to 11*d*. a lb. for £186 7*s*. 10*d*.

The figure of 1*s*. 10*d*. for *C. succirubra* bark is extraordinarily high compared with the other values ; presumably it was due to a temporary shortage in the market, as occurred with some Ledger bark in 1933 (see below).

The figures for the 1932–33 consignments of bark are more complete than any of the above and some interesting data can be obtained from them.

From the new trees planted out in 1922, 3,690 *C.*

[1] See footnote on p. 16.

Ledgeriana trees gave 3,707 lb. of dried bark, i.e. 1·03 lb. per tree, containing 9·84 per cent. quinine, as sulphate; this was sold at auction for the very unusual price, at that time, of 1*s.* 8⅜*d.* per lb. due to a temporary shortage on the market. The brokers had valued it at 1*s.* and in all other cases their valuations were never as much as 1*d.* out, so that for purposes of comparison the author proposes to call its value 1*s.* (two earlier consignments containing 9·40 and 9·48 per cent. quinine, as sulphate, both sold at 9*d.* per lb.). Now 3,600 trees at £180 17*s.* (i.e. 3,707 lb. bark at 1*s.* per lb.) is 1*s.* 0½*d.* per tree, and a yield of quinine sulphate of 373·6 lb. makes 10*s.* 0¼*d.* per lb.

At the same time, 2,833 hybrid trees gave 6,904 lb. of bark, or 2·44 lb. per tree, containing 4·33 per cent. quinine, as sulphate, or a total of 298·9 lb. This bark sold for £254 6*s.* 8*d.*, or 1*s.* 9½*d.* per tree, and the value of the quinine sulphate was 20*s.* 5⅛*d.* per lb.

From these two sets of figures we may draw two interesting conclusions: firstly, that a hybrid tree has more economic value than a Ledger one, the values of bark per tree being 1*s.* 9½*d.* and 1*s.* 0½*d.* respectively, although the quinine content of the hybrid bark is less than half that of the Ledger bark; this is due partly to the fact that the hybrid is more hardy and grows better in Amani, but chiefly because it is a larger tree and produces more than twice as much bark as the Ledger, namely, 2·44 lb. per tree as against 1·03 lb.; secondly, that the price does not depend to any extent on the quinine content since the buyers of the Ledger bark obtained the quinine sulphate at the rate of 10*s.* 0¼*d.* per lb. (even if the one very high purchase price of 1*s.* 8⅜*d.* per lb. of bark is taken, the quinine sulphate is only 17*s.* 3*d.* a lb.), whereas the purchasers of the hybrid bark paid 20*s.* 5⅛*d.* per lb. of quinine sulphate.

Still greater discrepancies in the value of actual quinine sulphate are found when considering the bark from the ratoons of the old German trees which was sold in 1932–33.

3,630 *C. succirubra* trees, giving 9,051 lb. of bark, i.e. 2·49 lb. per tree, containing an average of 2·10 per cent. quinine, as sulphate, realised £289 15*s.*; this works out at 1*s.* 7*d.* per tree and 30*s.* 5⅜*d.* per lb. of quinine sulphate.

4,563 *C. Ledgeriana* trees gave 10,023 lb. of bark, i.e. 2·19 lb. per tree, containing 916 lb. quinine, as sulphate, and realised £663 11*s.* 3*d.* If, however, allowance is again made for one consignment which sold for 1*s.* 8¼*d.*, due to the shortage (this and the one mentioned previously were sold together), instead of its normal value of 1*s.*, the sum of £453 6*s.* 6*d.* is obtained ; this gives 1*s.* 11¾*d.* per tree and 9*s.* 10¾*d.* per lb. quinine sulphate.

1,475 trees of mixed hybrid and *C. robusta* (about half of each) gave 4,472 lb. of bark, containing 239·5 lb. quinine, as sulphate ; this is 3·03 lb. bark per tree. It realised £137 5*s.* 10*d.*, which is 1*s.* 10¼*d.* per tree and 11*s.* 5½*d.* per lb. quinine sulphate.

The total amount of bark in 1932–33 was 34,961 lb., selling for £1,679 6*s.* 9*d.*, or an average of 11½*d.* a lb.

The various values are summarised in Table 7.

TABLE 7

Values of Cinchona species in Amani

Date.	*Ledgeriana.* Bark per tree.				*Hybrid.* Bark per tree.					*Succirubra.* Bark per tree.				
	Ledgeriana.	Value per tree.		Cost of Quinine Sulphate per lb.		Hybrid.	Value per tree.		Cost of Quinine Sulphate per lb.		Succirubra.	Value per tree.		Cost of Quinine Sulphate per lb.

Date.	Ledgeriana. Bark per tree.	Ledgeriana. Value per tree.		Ledgeriana. Cost of Quinine Sulphate per lb.		Hybrid. Bark per tree.	Hybrid. Value per tree.		Hybrid. Cost of Quinine Sulphate per lb.		Succirubra. Bark per tree.	Succirubra. Value per tree.		Succirubra. Cost of Quinine Sulphate per lb.	
	lb.	*s.*	*d.*	*s.*	*d.*	*lb.*	*s.*	*d.*	*s.*	*d.*	*lb.*	*s.*	*d.*	*s.*	*d.*
1908 . .	—	—		—		0·60	0	2	4	9	—	—		—	
1912 . .	—	—		—		—	—		—		0·73	0	1¾	6	6½
1913 . .	0·64	0	6⅛	7	8½	0·67	0	5	7	8½	—	—		—	
1932 (Old trees) .	2·19	1	11¾	9	10¾	3·03	1	10¼	11	5½	2·49	1	7	30	5¾
1933 (New trees) .	1·03	1	0⅛	10	0¼	2·44	1	9½	20	5⅛	—	—		—	
1932–33 (Average) .	1·61	1	6⅛	9	11½	2·73	1	9⅞	15	11¼	2·49	1	7	30	5¾

These figures show (1) that before the war the value of the barks depended entirely on their quinine content and, therefore, other things being equal, the tree with the highest quinine content was the most valuable to the grower ; thus, a Ledger tree produced 6⅛*d.* worth of bark at a cutting, a hybrid 5*d.* worth, and a *succirubra* tree only 1¾*d.* worth ; (2) that at present times the quinine content has very little to do with the price, the value of bark from a single tree being nearly constant for all the varieties and, in fact, slightly lower for Ledger than for the hybrid and

succirubra. The surprising fact emerges that the buyers will pay such widely different rates for the quinine; thus from Ledger bark the quinine sulphate costs only 9s. 11½d. per lb., from the hybrid 15s. 11¼d. and from *succirubra* as much as 30s. 5¾d. It is true that the last bark is seldom bought for quinine extraction, but is sold as "druggists' bark" in quills, when appearance counts most, but the hybrid is used largely for quinine extraction, as is Ledger, and yet the buyers will pay as much as 60 per cent. more for it.

As regards cultivation in Amani, the hybrid and *C. succirubra* are more hardy and grow better than *C. Ledgeriana*, and after cutting down the ratoons shoot up faster so that these two would appear preferable both from the point of cultivation and of profit. The demand for *C. succirubra*, however, is limited, and if large areas were grown difficulty might be encountered in disposing of the crop, so that the hybrid has proved, all things considered, to be the best variety to grow, providing, as was previously stated, freshly crossed seed be used.

More recent experience in Java, however, has led to the replacement of both Ledgeriana and hybrid trees by grafts of the former on *succirubra* stocks (Ref. 6). Where sufficiently skilled labour enables this to be carried out cheaply and efficiently the system combines the hardiness and rapid growth of *succirubra* with the high quinine content of *Ledgeriana*, and avoids the difficulties involved in recrossing to secure seed for each new generation.

Table 8 gives the collected data for all sales of bark which have been traced from the records (including that used during the war).

TABLE 8

Sales of Amani Cinchona bark

Date.	Weight of Bark.	Value.			Weight of Quinine Sulphate.
	lb.	£	s.	d.	lb.
1908 . . .	887	11	12	0	49
1912 . . .	6,600	66	10	0	202
1913 . . .	7,845	250	0	0	651
1914–16 . .	13,465	800	0	0 *	781 *
1919 . . .	16,500	825	0	0 *	1,400 *
1920 . . .	14,700	955	0	0	1,300 *
1932–33 . .	34,961	1,697	7	0	2,018
Total . . .	94,958	£4,587	9	0 *	6,401 *

* *Approximate.*

6. Cinchona Febrifuge

The author has conducted some experiments on the preparation of cinchona febrifuge from Amani barks. Several methods of extraction were tried but only one was found to be both convenient and effective.

Four kilos. of finely powdered bark were mixed with 18 litres of water containing 350 g. of sodium hydroxide, and then 18 litres of kerosene and 2 litres of fusel oil added and the whole mixture well stirred up for three hours. The oil was allowed to settle out on top and was run off, a further similar amount of oil added and the mixture again well stirred for two hours.

The two volumes of oil were added together and well stirred up with about 3 litres of 1 per cent. hydrochloric acid ; after settling, the acid was drawn off and a further 3 litres added and again well stirred.

The two amounts of acid were heated to boiling and a slight excess of sodium hydroxide added ; the precipitated alkaloids were filtered off and dried ; this dried mass constituted the febrifuge.

The initial sodium hydroxide may be replaced by lime, but the efficiency of the extraction is then somewhat reduced ; the addition of an alkali is necessary to liberate the free alkaloids in the bark as the compounds in which they exist in it are not soluble in solvents. The hydrochloric acid extracts the alkaloids as hydrochlorides from the oil and they are then precipitated as free alkaloids by the addition of alkali. The febrifuge is thus a mixture of the free alkaloids.

Febrifuges were prepared from *C. Ledgeriana* and from the hybrid, and full analyses were carried out on both. Table 9 shows the results obtained.

TABLE 9

Composition of Cinchona Febrifuges

—	*Ledgeriana.*		Hybrid.	
	Per cent. of Bark.	Per cent. of Febrifuge.	Per cent. of Bark.	Per cent. of Febrifuge.
Yield	9·18	—	10·00	—
Quinine	7·22	78·6	5·19	51·9
Cinchonidine	0·35	3·8	0·33	3·3
Cinchonine	nil	nil	1·70	17·0
Quinidine	nil	nil	nil	nil
Amorphous	1·62	17·6	2·78	27·8

These figures agreed very closely with those obtained by previous complete analysis of small samples.

Samples of the febrifuges were forwarded to the Medical Departments of Kenya and Uganda for testing against malaria, but reports on the results have not yet been received in Amani.

The possibility of the general use of cinchona febrifuge in place of the more expensive quinine or synthetic products for anti-malarial work amongst the natives of East Africa should not be overlooked, and there are signs that the local Medical Departments are once more interested in the matter.

7. Situation, Climate, etc.

All the old cinchona trees in Amani are planted in poor, sandy soil on fairly steep slopes ; the new trees, planted in 1922, are in a red loam on moderate slopes.

The elevation of the former is between 3,200 and 3,700 ft., and of the latter between 2,750 and 2,900 ft.

The average rainfall over thirty-four years is 76 in., with extremes of 53·8 and 97·8 ; the humidity is very high at nearly all times and the mean annual temperature is 68·9° F. with a mean daily minimum of 61·5° F. and maximum of 76·3° F.

8. Summary

(1) A short historical survey of cinchona in Amani is given.

(2) The alkaloid content of the various barks in different years is given, 10·55 per cent. quinine, expressed as sulphate, in Ledger bark, and 11·21 per cent. in hybrid bark, being the highest obtained at any time.

(3) The yields of bark from the various species are given and results show that *C. Ledgeriana* produces considerably less than the others.

(4) The market value of the various barks is discussed, and it is shown that the hybrid commands the best price per tree, *C. Ledgeriana* having the lowest value.

(5) A description of the preparation of cinchona febrifuges and their composition is given.

(6) A few notes on climate, etc., in Amani are given.

9. References

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SCIENTIFIC ASPECTS OF CACAO FERMENTATION

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PART I

A Field for Research

The fermentation of cacao is an old process that has been evolved naturally by the method of trial and error. Only in comparatively recent years have men with scientific knowledge examined the process, and although revolutionary proposals have been made from time to time, none of them have found favour with the planters. It is doubtful if the scientists can justly claim to have produced in their experiments a better product than the experienced planter produces by the traditional methods. The scientists have, however, been of great assistance by making detailed statements and distributing the knowledge of the best methods round the world, and in encouraging the less informed planters to improve their methods. As a result, the amount of fermented cacao which is produced to-day is greater than at any time in the past. A great advance has been made in the last twenty years, for to-day the greater part of the cacao which comes into the market is fermented, and much of it "well fermented."

With regard to the application of science to the process, we are now on the threshold of a new era, and on the foundations which have been laid we may shortly see an imposing edifice of accurate knowledge.

The fermentation of cacao is a subject which offers a wide field to the enquiring mind, and is one in which the application of research methods *on the spot*, and the use of up-to-date biochemical knowledge, would yield a harvest of information. Much remains to be done. At the present time it is not possible by reference to the published records to compile a complete scientific explanation of the fermentation of cacao. Many planters know how to carry out the process to the entire satisfaction of the buyers of cacao beans, but those who superintend the work on the cacao estates have generally had insufficient training or equipment to investigate the theory of the subject. On the other hand, scientists in Europe seldom have an intimate knowledge of the process, and are unable to obtain fresh seeds on which to experiment. Even if they had the knowledge and the material, they would still have found it difficult to define the ideal conditions of production because it was not until 1933 that the cocoa and chocolate manufacturers as a body stated exactly what they wanted [1]. However, there has been for a long time a very definite and reliable indication that the manufacturers prefer fermented to unfermented cacao: given cacao of the same type from any one producing country, the manufacturers will pay more for the fermented than the unfermented. Researches in the past have been carried out mainly in various Agricultural Departments in the tropics, and we owe much of our present knowledge to the time which busy officials gave to this work in the midst of many duties. Now that we have Agricultural Colleges in Trinidad and other tropical places, and increased facilities for research, we may expect to see great advances in this subject.

It is proposed here to give a brief review of the published knowledge of cacao fermentation at the present time, with the addition of any information or critical comment that arises from the author's experience or experiments. Many of these experiments could not have been carried out without the kindly co-operation of certain planters and agricultural officers in the tropics. This review will, the author believes, prove his contention that the present theory of cacao fermentation is incomplete and cannot, therefore, form a satisfactory

basis for practical attempts to find a substitute for fermentation. Whilst the theory is incomplete, it will be found to explain much that happens in fermentation. The one direction in which the theory is notably inadequate is in the explanation of the flavour development.

Varieties of the Cacao Seed or "Bean"

The fresh seed consists of a small white radicle (the so-called germ) and two folded fleshy cotyledons enclosed in a thin leathery skin. As taken from the pod the "bean" is surrounded by a whitish mucilaginous pulp. Whilst the manufacturer notes that the cacao from every producing area has distinctive characteristics, there are for him two fundamental kinds of commercial cacao beans, namely, those prepared from beans with a white interior and those prepared from beans with a purple interior. There are also intermediate kinds showing different intensities of purple. The simplest botanic classification recognises two main varieties of *Theobroma Cacao*—*Criollo* (usually having seeds with a white section), and *Forastero* (usually having seeds with a purple section). In the author's opinion, the botanic classifications of the past based on the properties of the *pod* have not proved entirely satisfactory either to the manufacturer or the chemist. It is now known that the Criollo pod appearance is a dominant [2], and that a pod with the recognised Criollo characteristics may contain purple beans. For example, the author noted that a few Criollo trees which have been carefully cultivated on the Gold Coast, where Forastero trees abound, yield pods and beans which externally have the appearance of being Criollo, but on cutting the beans they are found to be purple in colour and astringent in taste. On the other hand, those cacao trees growing in Ceylon, which the planters there call Forastero, bear pods which contain on the average 63 per cent. purple seeds and 37 per cent. white seeds. Whilst it cannot be said that from the colour of the bean one can at once assume all its other properties—indeed it is known that the purple colour of the seeds may in some cases conceal a predominance of Criollo characteristics—nevertheless one finds from experience that the flavour and composition

are closely related to the depth of colour. From the commercial point of view the colour of the interior of the bean is the simplest indication of the kind of product which the manufacturer expects to obtain from the beans.

As over 90 per cent. of the world's cacao beans when first taken from the pod are purple, the purple bean will receive the greater attention. Whilst doubtless further knowledge will reveal other qualitative differences, in the present state of our knowledge it is convenient to assume that the white beans (or Criollo) contain the same constituents as are present in the purple beans (or Forastero), save the purple substance and a substance which becomes red on exposure to light.

Loss on Fermentation and Drying

The juicy beans must be dried to make them into a stable article of commerce. It was probably discovered by accident that they dry more easily if they have first been allowed to ferment. Fermentation is an easy way of getting rid of the pulp. In Ceylon, where the pulp is removed by *washing*, it is first loosened by a very mild fermentation [3, 4]. Besides removing the pulp, fermentation produces changes in aroma, flavour and colour, which are of importance to the manufacturer. The quantity of pulp on the beans and the amount of sugars in the pulp obviously affect the intensity and duration of fermentation. These vary with the kind of cacao, and with the season, the quantity and quality of the pulp being factors over which the planter has little or no control. On the average the pulp contains about 80 per cent. of water. In the preparation of the beans for the market losses of water and other substances occur, the losses varying slightly according to the method adopted. If the beans are dried direct they lose, on the average, about 61 per cent. of their weight. This loss is mainly due to water. If the beans are in the first place fermented, they lose about 11 per cent. by evaporation, whilst about 13 per cent. of a sugary liquid called "sweatings" runs away. On drying the fermented beans there is a further loss of 40 per cent. by evaporation. These figures, founded on the author's experiments with Trinidad cacao, are in agree-

ment with Hudson's statement [5] that 100 lb. of fresh beans yield 39 lb. of unfermented cacao beans of commerce by merely drying, or 36 lb. of fermented beans of commerce by fermentation and drying. Other published figures for yields are for Surinam 32 per cent. (Van Hall), or 34 per cent. (Fauchère), for Trinidad 38 per cent. (Augustus), and for Madagascar 40 per cent. (Fauchère).

Arrangements Used for Fermentation

Presumably in all countries the original method was simply to heap the beans or place them in a hole in the ground. These methods still exist in the more primitive areas. Below will be found critical comments on these methods, which are contrasted here, and later, with the use of containers.

(1) *The hole or pit.*—In Nigeria small basin-shaped holes lined with plantain leaves have been much used, but the employment of co-operative fermenting houses is gaining ground. Holes or pits are poor receptacles for three reasons: (*a*) the "sweatings" cannot easily run away, (*b*) aeration is reduced to the minimum, and (*c*) in rainy weather the fermenting beans are cooled and drenched by the water which collects. Both in Nigeria and on the Gold Coast placing in a hole was the original method, probably because of the natives' previous experience with palm nuts. On the Gold Coast it has been replaced by the use of the heap [6].

(2) *The heap.*—Heaping is the method most generally used by native farmers all over the world. The beans are placed on leaves and covered with leaves. The method is popular also with Europeans in Venezuela, Java and Brazil (Para). In Ecuador the intention appears to be simply to dry the beans, but at intervals during the drying the beans are heaped and some fermentation accidentally occurs.

The chief faults of the heap are that (*a*) there is insufficient aeration and (*b*) the beans at the bottom of the heap tend to keep cold.

(3) *Boxes, baskets, frames of plantain stems, raised bamboo frames.*—The use of containers is the more generally approved method. The illustrations (Plates I and II)

show the native baskets as used in Ashanti, the frames of plantain stems as used on the Gold Coast and Ivory Coast, and the raised bamboo frames sometimes used in Nigeria. The plantain stem frames are popular because the plantain stumps occur in the plantations and can be easily cut to the exact dimensions required for the particular picking.

Whilst the best of the world's Forastero cacao is produced in boxes, much depends on the skill of the operator. The author has described the tests which he carried out on these types of containers in his paper on *Cacao Fermentation in West Africa* [6]. He concludes: "Although fermentation proceeded somewhat more satisfactorily in the three-tier box than in either of the other containers, after a careful examination of all the beans—both before and after roasting—the author decided that there was little to choose between the box, basket or plantain stem frame as containers for the conducting of fermentation."

Boxes, generally called "sweat" boxes, are made of slate, stone, cement or, more usually, of some hard native wood. On the Gold Coast odum wood (*Chlorophora excelsa*) is used, and in the West Indies the native cedar (*Cedrela mexicana*) or cypre (*Cordia alliodora*). Iron nails are objectionable as they stain the beans black owing to the formation of iron salts with the citric acid in the pulp and the tannins in the beans. Joints should be made with wooden pegs or by "dove-tailing." For the same reason wooden shovels are used to turn the beans, and in Ceylon to avoid the use of steel knives the pods are on some estates broken with a mallet.

Conditions controlling Fermentation

Whichever of the above arrangements are used, the beans after a time begin to ferment, the temperature of the mass rises and the pulp breaks down and partly drains away. With Forastero cacao under satisfactory conditions, after six or seven days the pulp on the outside of the beans is a dirty brown. The taste of the pulp and the appearance of the interior when the bean is cut through are also greatly changed. The planter, however, either ferments for what he considers a suitable number of days or judges when the fermentation has reached a satisfactory

(*Photo by A. W. Knapp.*)

FIG. 1.—NATIVE FERMENTING BASKET AS USED IN ASHANTI.

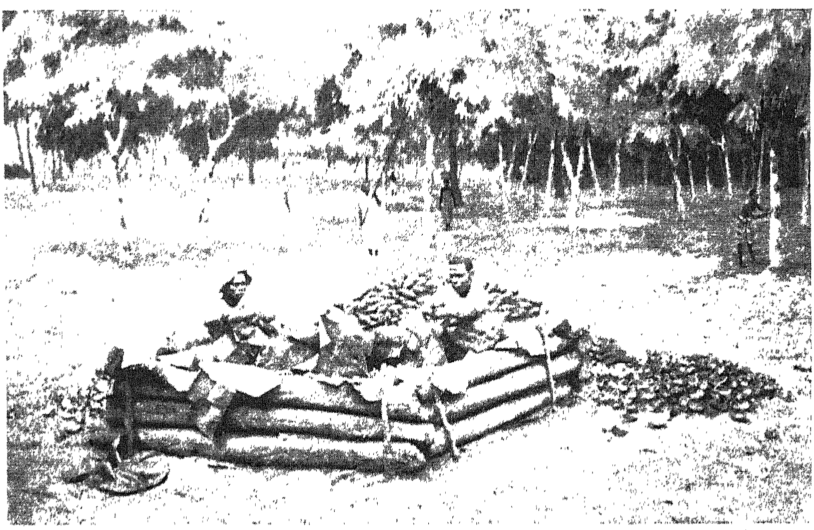
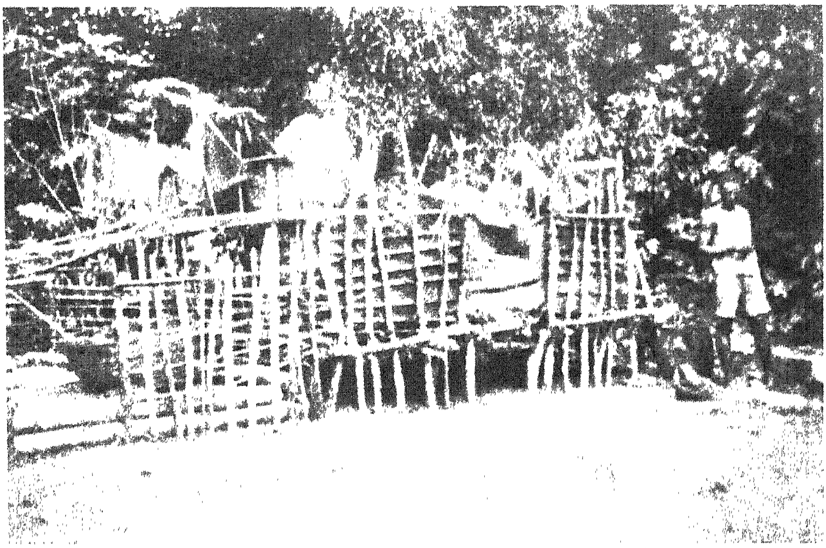


FIG. 2. THE PLANTAIN STEM FERMENTARY (AS USED ON THE GOLD COAST AND IVORY COAST).

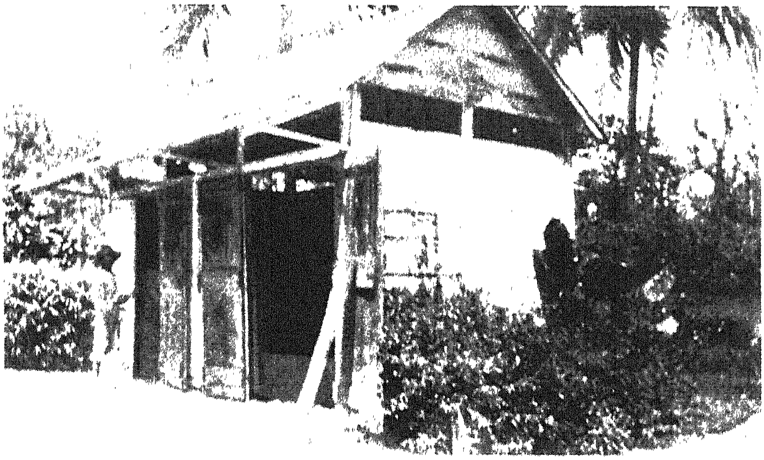
Photograph of part of a diorama in the Gold Coast Court of the Exhibition Galleries, Imperial Institute.

PLATE II.



(Photo by A. W. Knapp.)

FIG. 1. RAISED BAMBOO FRAMES, AS USED IN NIGERIA.



(Photo by A. W. Knapp.)

FIG. 2. SHED CONTAINING LARGE SWEATING BOXES (TRINIDAD).

Note space between side of box and wall, ample ventilation at top, and protection from rain whilst filling.

stage solely by the external appearance (i.e. by the colour of the pulp, the presence of purple exudations and the plumpness of the bean).

It is proposed to discuss separately in detail the changes in the pulp and in the interior of the beans. The first are due to micro-organisms, and the second mainly to enzymes. Before doing this it may be well to say a few words on the general conditions controlling the fermentation. There is in general no attempt scientifically to control the temperature, moisture distribution, aeration or organisms present, but certain arrangements are made which have some effect on these.

(a) *Temperature Control*

As the control of the temperature of the fermenting mass of beans is important, it is advisable not to have the mass of cacao in a position exposed to the winds. For the same reason it is usual, whatever method is used, to line the receptacle and to cover the beans with a blanket of freshly cut banana or plantain leaves. Demandt [7] has shown how in cloudy, sultry weather the temperature of the fermenting mass, as might be expected, rises higher than in breezy or normal weather. It is a great advantage to have a space of about 4 inches between the wall of the building and the side of the " sweat " box—thus forming a double wall with an air space. This is sometimes done to save pressure on the walls of the building, but it has other definite advantages. This air jacket not only protects the beans from rapid changes of temperature due to the wind and weather, but allows of aeration all round the mass.

(b) *Moisture Control*

As it is generally agreed that the mass of the beans should be moist but not sodden, it is usual to allow the juice or sweatings to run away. If a hole in the ground is used this is often impossible, and in a heap or stem frame container the drainage is apt to be imperfect. With boxes, satisfactory drainage is obtained by sloping the floor, or better, by having a raised false floor, which is either perforated or has spaces left between the boards. If the

pulp on the beans is scanty and dry it is advisable to moisten the cacao with a sugary solution.

(*c*) *Aeration Control*

Air is essential to good fermentation—it makes the yeast grow more vigorously; it prevents the growth of objectionable anaerobic organisms, and is essential to the oxidation of the tannin in the later stages. Aeration is imperfect in masses of cacao placed in holes or made into heaps. Boxes are generally raised six or more inches off the floor to allow air to circulate freely, and the shed containing the boxes is usually well ventilated at the top.

(*d*) *Size and Arrangement of Fermenting Masses*

The amount of cacao fermented in separate lots depends in practice on the weight of the cacao picked and on the size of the container where containers are used. In native fermentation the heaps, boxes or baskets are often too small to give a satisfactory fermentation. Any mass below 100 lb. has so much surface in relation to volume that too much cooling occurs. Where boxes are used, the size and arrangement of them appears at present to be a matter of taste; for example, the author visited a large number of plantations in Trinidad, and every fermentary had a different-sized box, or a different grouping of boxes. It is evident that both size and grouping must have an effect on the temperature curve. In very large boxes aeration is imperfect. In small boxes the surface allows too much cooling to take place.

(*e*) *Mixing*

It is agreed in all countries that the beans should be given a good mix once a day or every other day. They may be either mixed *in situ* or turned from one receptacle to another. The effects of neglecting this will be described later. Mixing is always a laborious process, particularly when performed in the hot moist atmosphere of the fermentary. Various labour-saving devices for mixing have been suggested, e.g. the boxes are built like steps one above another. Boxes which can be rotated are sometimes

used: the diagram (Fig. 1) shows one which has been patented [8]. This mixing causes a slight temporary drop

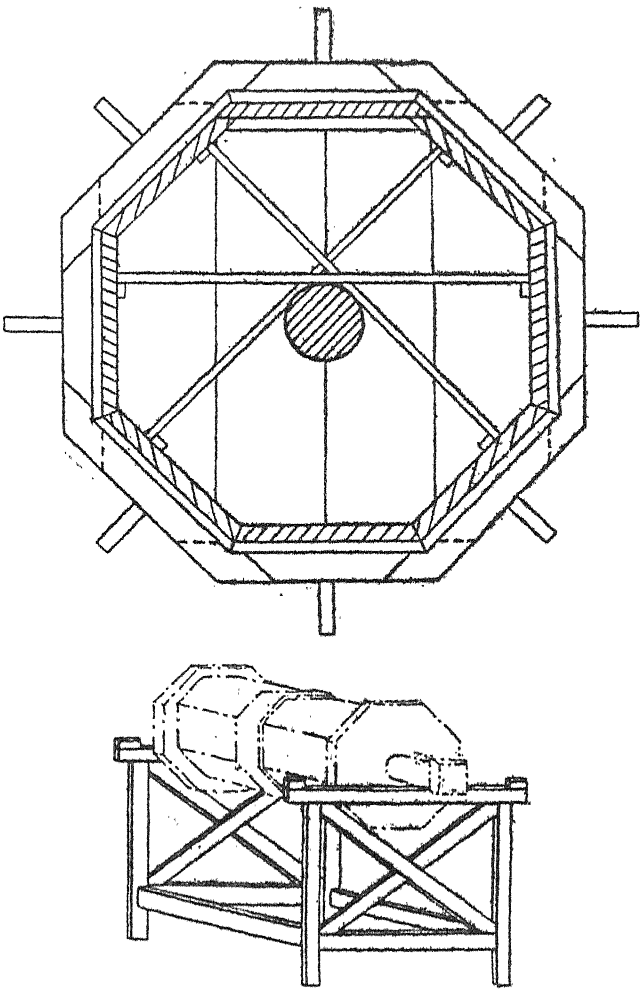


FIG. 1.—Whitworth's patented octagonal box (with sliding lid) showing cross section and perspective view.

in temperature (see later), and has the advantage that the yeasts and other organisms are distributed more evenly throughout the mass and additional aeration occurs.

Fermentation of the Pulp

The fermentation of the pulp will now be discussed, mention being made of the micro-organisms found, the advantage, if any, of using a pure culture as an inoculum,

the temperatures observed, the nature of the sweatings and the observed changes in the pulp. The changes in the interior of the bean will be discussed later.

Micro-organisms found in Cacao Fermentation

The liquid in the pulp contains about 10 per cent. of reducing sugars (presumably dextrose and laevulose), and 2 per cent. of mucilage and pectin. It is slightly acid. Pulp is obviously a good medium in which to grow yeast and mould. It is not too acid for certain bacteria to thrive thereon.

The cacao pods are broken and the beans are extracted in the plantation. The beans may be made into a heap on a well-drained spot nearby as on the Gold Coast, or they may be placed in trucks on wheels as in San Thomé, or carried—sometimes considerable distances—to the fermentation receptacles. They are thus exposed to any micro-organisms that may be in the air, as well as to those in the receptacles. The author examined cacao beans in Trinidad as they were put into the box and could find very few organisms. After twenty-four hours the pulp swarmed with yeast cells, but the numbers varied greatly in different parts of the box. (It has been pointed out by Nicholls [5] that a minute fruit-fly (*Drosophila melanogaster*) assists materially in distributing the yeasts and bacteria. The author has often seen the fruit-fly in box fermentaries but very seldom on unturned heaps. Whether this visitor should be welcomed is doubtful.) After about forty hours the author found many budded yeasts, and after sixty hours the pulp contained large quantities of bacteria. In heaps on the Gold Coast the author has seen many non-motile bacteria on the third day.

Nicholls states [5] that there is no acetic acid, or other volatile acid, in the fresh fruits; Hardy has shown that the only acid present in the fresh pulp and bean is citric acid [9]. According to the author's observations, the amount of acid estimated as citric in the fresh pulp varies from 0·8 to 0·9 per cent. (Nicholls found less) and no appreciable quantities of acetic acid are produced during the first forty hours. This indicates that acid-producing bacteria are not, up to that time, present in quantity on the cacao.

Different observers have found a variety of yeasts and

bacteria : their observations are summarised in the following tables. The first shows the micro-organisms actually found on fermenting cacao in the tropics, and the second the moulds and yeasts found on the dry cacao beans of commerce. More attention has been given to variation in the organisms found than to the natural variation in the composition of the pulp on which they grow.

MICRO-ORGANISMS FOUND ON FERMENTING CACAO

Observer.	Kind of Cacao.	Micro-organism.
Chittenden (1899)	Trinidad	(1) *Saccharomyces cerevisiæ* and probably *Penicillium glaucum*.
—	—	(2) Lactic-acid and probably butyric-acid bacteria.
Preyer (1901)	Ceylon	(1) *Saccharomyces theobromæ* (Preyer), resembles *S. ellipsoideus* (Hansen) and *S. membranæ faciens*. Length 0·006 mm., diameter 0·003 mm.
—	—	(2) Bacilli and moulds (*Penicillium*).
Loew (1907)	Porto Rico	(1) *Saccharomyces ellipsoideus* with some *S. apiculatus*.
—	—	(2) Acetic-acid bacilli.
Nicholls (1912)	St. Lucia	1st stage—Yeast, mainly "wild" yeasts (including *S. theobromæ*).
—	—	2nd stage—Acetic-acid-producing bacteria (bacilli and micrococci).
—	—	3rd stage—Putrefactive bacteria and moulds.
Bainbridge and Davies (1912)	Jamaica	1st stage—*S. apiculatus*, small quantities of *S. anomalus*.
—	—	2nd stage—Enormous development of true saccharomyces.
—	—	3rd stage—Acetic-acid bacteria.
—	—	4th stage—Spore-bearing bacilli of *B. subtilis* type.
Lutz	—	*S. theobromæ*, *Sterigmatacystis niger*, *Pseudo-absidia vulgaris*, and a new fungus, *Fusarium theobromæ* (Lutz).
Steinmann (1927)	Java	After 12 hours: *S. apiculatus*, later *S. ellipsoideus*. After 6½ days *Aspergillus glaucus*, *Penicillium glaucum* and *Oidium lactis*.
Schwarz and Thom (1928)	Gold Coast	*Aspergillus niger*, *A. flavus* and *A. tamarii*. Mucors, especially *Rhizopus*. A few yeasts. Aerobic spore-forming bacteria including mesenteric group.
Bunting (1928)	Gold Coast	*Aspergillus fumigatus*. *Cymomucor* 463, and others.
Ciferri (1931)	San Domingo	Eight yeasts normally present (see below) and nine others.
Briton-Jones (1934)	Trinidad	First thirty-six hours mainly *S. apiculatus*, later *S. ellipsoideus* predominates.

MICRO-ORGANISMS FOUND ON THE DRY BEANS OF COMMERCE

Observer.	Kind of Cacao.	Micro-organism.
Reinke (1927)	Various	142 strains of *Aspergilli* of which the most frequent were—*Aspergillus flavus* and *A. niger* (75 per cent.), *A. Sydowii* and *A. tamarii* (50 per cent.), also *A. repens*, *A. terreus*, *A. carbonarius*, *A. versicolor* var. *flavipes*, *A. candidus*, *A. giganteus*, *A. ochraceus* and *A. versicolor*.
—	Haiti	*Aspergillus niger*, *A. tamarii*, *A. carbonarius* and *A. flavus*.
Lilienfeld-Toal (1927)	Various	*Saccharomyces ellipsoideus* var. *tropicus*, *Saccharomyces Bussei* and *Schizosaccharomyces anomalus* and four undetermined.
Bunting (1928)	Gold Coast	*Aspergillus glaucus* (*Chevalieri ?*), *Penicillium* sp.
Busse, Henneberg and Zeller (1929)	Various	Green, brown and black *Aspergilli*, *Mucoraceæ*, *Penicillia*, *Cladosporium*, *Cephalothecium*, *Fusarium* and *Botrytis*.
Ciferri (1931)	San Domingo	*Aspergillus niger*; *A. fumigatus*. *A. flavus*, *A. glaucus*; *Penicillium leucopus*, *Rhizopus nigricans*, *Mucor mucedo*, *Spicaria lateritia*, *Cephalosporium acremonium*.

(For sources of information see references 5, 10, 11, 13, 15, 16, 17, 18, 19, 21 and 22.)

The micro-organisms found on fermenting cacao have a more direct bearing on our subject than those found on the dry beans, although in some cases the second supply a useful confirmation of the first. It will be seen later that the existence of mould inside the dry beans is made possible by certain organisms present during fermentation.

The Yeasts

The most complete investigation of the yeasts present during fermentation is that made by Ciferri [15] in his examination of San Domingo cacao. The table on page 43 gives all the yeasts which he found normally present.

From Lilienfeld-Toal [11] and other investigators it appears that the first four of these eight are probably found on fermenting cacao in most countries. Of these, *Endomyces anomalus* is the cosmopolitan yeast formerly known as *Saccharomyces anomalus*; and *Eutorulopsis theobromæ* is the same as the yeast called by Preyer

Yeast.	Fermenting Beans. Fermentation.			Dry Beans.	Optimum Temperature of Growth.
	Beginning.	Full.	End.		
Saccharomyces ellipsoideus var. *tropicus*	**	****	***	***	40° C.
Endomyces anomalus	***	**	**	**	—
Schizosaccharomyces Bussei	*	***	***	**	40° C.
Eutorulopsis theobromæ	***	****	****	***	35° C.
Saccharomyces ellipsoideus var. *domingensis*	**	***	***	***	—
Klockeria cacaoicola	***	**	*	o	35° C.
Torulopsis Lilienfeld-Toalii	**	***	****	*	40° C.
Klockeria domingensis	***	*	o	o	—

* indicates very rare ; ** rare ; *** common, and **** very common.

Saccharomyces theobromæ, and for which he made special claims in relation to cacao fermentation.

It would appear from the above tables that yeasts similar to those which produce beer and wine have worked satisfactorily with cacao. Preyer [10] and Nicholls [5], however, have both emphasised the importance of using the special culture, *S. theobromæ* (*Eutorulopsis theobromæ*). It would certainly be more scientific to aim at working under standard conditions always with pulp of the same composition and to inoculate always with the same pure culture or cultures. As we have seen from the tables of yeasts and bacteria found, there is a succession of organisms as the conditions change, and Briton-Jones [22] has pointed out that this has been ignored by those who advocate a single pure culture. The insistence on fermenting solely with a pure culture would necessitate sterilising the mass of beans, which, apart from the expense, would be detrimental because it would destroy certain useful enzymes. In order to get a standard fermentation, however, it would only be necessary to add sufficient of the pure culture to swamp the adventitious organisms. In the author's experience, the addition of yeast when cacao is put in the box is an advantage because it saves waiting twenty-four hours for the multiplication of those yeast cells which are accidentally present. Although it may be sound as a scientific theory, further evidence is required before it can be considered as established that superior cacao is produced by the use of a pure culture of a parti-

cular yeast. The author found [12] that the addition of one pint of ordinary yeast obtained from a Trinidad brewery started fermentation earlier, and produced as good a cacao as, and in one day less than, the ordinary fermentation. A sample of tinned yeast, as sold to bakers, assisted the fermentation in its early stages, but did not produce quite so good a product. Until the different effects of different yeasts have been fully explored, the planter is probably justified in being satisfied with the yeasts which occur naturally in his fermentary. These yeasts, after many fermentations, have outlived other varieties, and are, therefore, obviously suited to the particular medium and environment. The planter would, however, save a day by deliberately cultivating this mixture or other suitable yeast outside his fermentation boxes, and adding it to the cacao when first put into the box. It remains for the Agricultural Departments, or some enterprising firm, to produce for sale pure cultures of good cacao yeasts. These would be sold with the food materials (glucose and salts) on which they will thrive and multiply. This should be accompanied by suitable directions, such as Nicholls gives in his paper [5], to enable the planter to cultivate the yeasts for himself in the glucose medium, using the pure culture merely as a starter. By the use of this fresh growth the planter would not necessarily produce exceptionally fine cacao, but he would turn out a more constant product, prevent the occasional loss due to abnormal fermentations and reduce his period of fermentation. The view may be taken that the kind of yeast is a factor in the development of some chemical substances in small quantity that are of importance to the final production of the flavour of the roasted bean. In that case one can only wait for proof. In the meantime it is worth noting that, according to Vargas Eyre, when the desire was to increase the amount of glycerin produced during alcoholic fermentation, "It was of course assumed at first that a special strain of yeast was necessary for glycerin production, and races of yeast have been described and their use patented, which are said to be particularly adapted for glycerin production. Recent investigations, however, seem to show definitely that the only two factors that come into consideration are

the age and vigour of the yeast culture used and a gradual acclimatisation of the yeast to the abnormal conditions under which it is called upon to live and grow" [13].

The importance of the bacteria and moulds in relation to cacao fermentation will be dealt with later after some account of the temperatures obtained has been given.

Temperatures for Normal Fermentation and some Experimental Variations

In fermentation the question of temperature is one of supreme importance. It is the simplest indication that a fermentation is proceeding normally. Uniformity of temperature throughout the mass is desirable as showing that all parts are fermenting evenly. After the first day, and before any mixing has taken place, the temperature of the cacao varies greatly from place to place. After mixing, the author noted that in Trinidad and Gold Coast sweat boxes or other containers the mass is generally warmest at a distance from the surface of one-third the total depth of the beans. The bottom is always the coldest. Ignoring the very bottom, the variation throughout should not be more than 3° C. (5° F.). Save in the early stages, there is naturally a falling off towards the sides [14]. Thus if the centre of the box is 48° C. (118° F.) a few inches from the sides it may be 46° C. (115° F.) and at the outside 43° C. (109° F.). In heaps one obtains a wider range of temperatures, the upper part of the heap averages 5° C. (9° F.) lower than the centre and the bottom of the heap is frequently 10° C. (18° F.) lower than the centre.

The chart on page 46 shows the temperatures the author obtained [12] under a variety of conditions using the same cacao (Trinidad cacao, mainly Forastero).

Curve 3 shows a normal fermentation of 10 cwt. of beans. The temperature in this case rises to 51° C. (124° F.) in five days, and then falls. Curve 5 shows a normal fermentation in a barrel (containing 3 cwt.) protected from temperature changes by being placed in a shed. This having relatively more area exposed rose more slowly, but being protected from the wind, gave good results. According to Briton-Jones similar unprotected barrels give poor results. Curve 6 shows what happens if one attempts

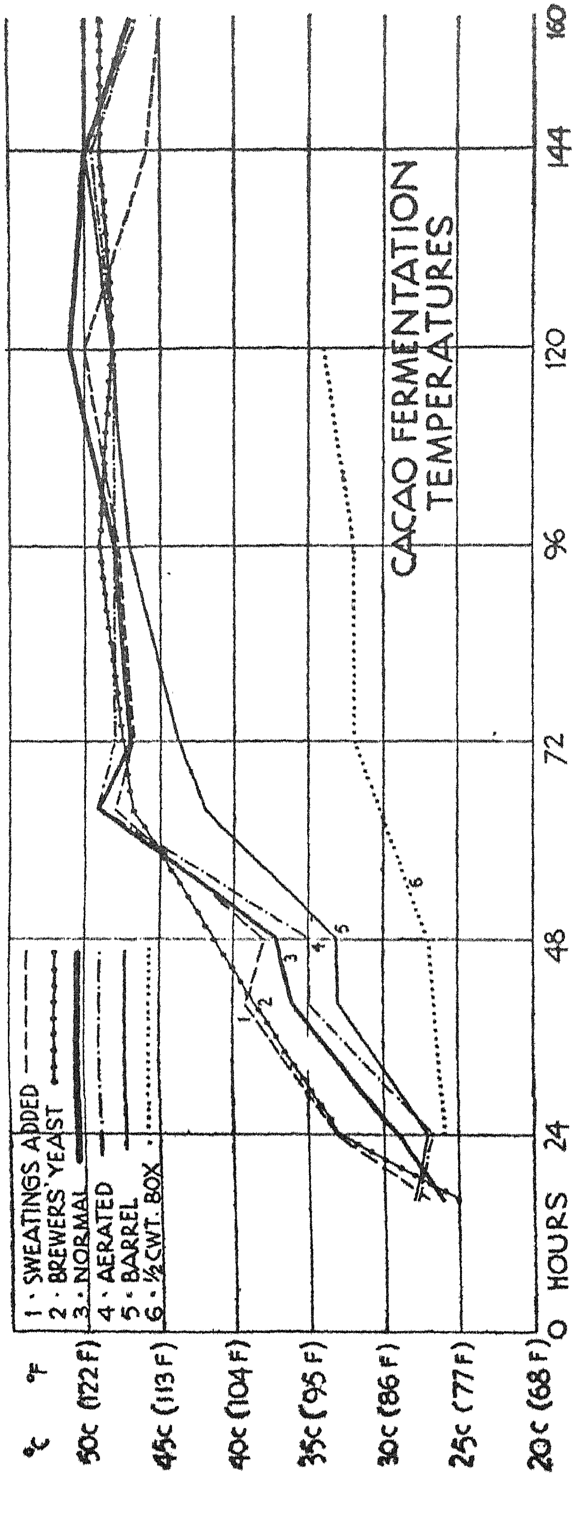


FIG. 2.—Temperatures observed in various sweat boxes in Trinidad. Quantity of beans 8–10 cwt. unless otherwise stated. Beans turned after 16, 40, 68, 88 and 112 hours.

to ferment as little as ½ cwt. in a box which is not protected from air currents. The temperature rises only a few degrees and the beans are only partially fermented. It is worth noting, however, that the beans appeared to die although the temperature never exceeded 34° C. (93° F.). Curve 2 shows one of the experiments in which ordinary brewers' yeast was added when the beans were put in the box. From the twenty-fourth to forty-eighth hour the temperature was at least 3° C. (5° F.) higher than usual, and at the end of the third day the beans were as advanced in appearance as the ordinary after four days.

A similar advantage was obtained, as is indicated by curve 1, by adding the sweatings (from beans which had been in the box twenty-four hours) to beans which had just been placed in the box. In order to obtain greater aeration perforated bamboo pipes were arranged horizontally through the mass of beans ; the temperatures obtained are shown in curve 4. The beans so produced appeared identical with those fermented under normal conditions, the additional aeration apparently in this case being no advantage. Perhaps the result would have been better if the bamboos had been removed when the acetic fermentation set in.

The turning of the beans from one box to another has the advantage of distributing the fermenting organisms and allowing aeration. It causes a very appreciable fall in temperature which may vary according to the time taken from 2° C. to 10° C. (4° to 18° F.) [14]. The temperature, however, generally rises again after mixing.

The author made a number of observations in Trinidad and Grenada of the temperature of fermenting cacao beans. The majority were in boxes which held about 8 cwt. of beans, but some held as much as 30 cwt. The beans were usually about 3 ft. deep. The averages are recorded below :

Average Temperature of Cacao Fermentation

(Boxes in Trinidad and Grenada)

After 0 days	25° C. or 77° F.
„ 1 day	30° C. or 86° F.
„ 2 days	37° C. or 99° F.
„ 3 „	47° C. or 117° F.
„ 4 „	48° C. or 118° F.
„ 5 „	49° C. or 120° F.
„ 6 „	49° C. or 120° F.

TEMPERATURES OBTAINED ON THE GOLD COAST

	Heap.	3-tier Box.	Basket.	Stem Frame.
After 0 days	27° C.	27° C.	27° C.	27° C.
,, 1 day	33° C.	31° C.	29° C.	28° C.
,, 2 days	43° C.	36° C.	35° C.	36° C.
,, 3 ,,	50° C.	44° C.	42° C.	38° C.
,, 4 ,,	49° C.	47° C.	46° C.	43° C.
,, 5 ,,	49° C.	49° C.	45° C.	41° C.
Weight of cacao		640 lb.	270 lb.	640 lb.

On the Gold Coast the author made a comparison of the box, basket and stem frame with the heap [6]. In the early stages the heap, as compared with the containers used either on the Gold Coast or in Trinidad, rises rapidly in temperature. The various heaps showed considerable variations: temperatures of 50° C. after three days were quite common and high temperatures were often reached on the second day. The three-tier box system used on the Gold Coast often has the boxes, particularly the second and third boxes, somewhat exposed to the atmosphere—hence the temperatures obtained are not in the early stages so high as those obtained in the more protected boxes in Trinidad, Java, Samoa, etc. The lower temperatures obtained in the basket were due to the smaller quantity fermented, and in the stem frame to the small depth, imperfect packing and direct contact of the layer of beans with the cool earth. (The temperatures of unripe and over-ripe cacao obtained during fermentation will be discussed later.)

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(*To be continued*)

THE PRODUCTION OF BEESWAX IN THE EMPIRE

THE waxes are a group of solid substances of animal, vegetable or mineral origin. Among the commercial animal waxes are beeswax, spermaceti and insect or Chinese wax. The vegetable waxes include sugar-cane wax, candelilla wax and carnauba and other palm waxes. The mineral waxes, the chief of which are paraffin wax, ozokerite, ceresin and montan wax, differ widely in composition from the animal and vegetable waxes and thus from the chemical standpoint form an entirely distinct class of substances.

To the dwellers in one, at least, of the world's centres of civilisation, that which developed about the shores of the Mediterranean Sea, beeswax became of importance at a very early date. This is not surprising, because of all

the animal or vegetable waxes, beeswax is the one most widely distributed in the world and capable of being used with the minimum amount of preparation. The plants producing sugar-cane wax, carnauba and other palm waxes grew in countries unknown to the inhabitants of the classical world, whilst the insect wax of China was similarly inaccessible.

Bees, however, were common, and were from very earliest times appreciated as the suppliers of a valuable foodstuff, as indicated by the description of a territory offering attractions for settlement as " a land flowing with milk and honey."

Beeswax, in those days the only " wax," was well known to the Greeks, Romans and Phœnicians, and was an article of international commerce. Pliny describes and places in order of value four grades of wax ; Punic or Carthaginian the best, Pontus wax, Cretan wax, and Corsican wax.

Attention to quality was considered important even in those early days, and Pliny's description of the preparation of Punic wax is worth quoting, especially for its account of the method of bleaching wax, resembling in essentials that still often followed :

" The Punic wax is prepared in the following manner : yellow wax is first bleached in the open air, after which it is boiled in water from the open sea, with the addition of some nitre. The flower of the wax—or, in other words, the whitest part of it—is skimmed off with spoons, and poured into a vessel containing a little cold water. It is again boiled in sea water by itself ; this done, the vessel is left to cool. This operation is three times repeated and the wax is then left in the open air, exposed on a mat of rushes, to dry in the light of the sun and moon respectively, for while the latter adds to its whiteness, the sun helps to dry it. In order, however, that the wax may not melt, it is covered with a linen cloth ; thus refined, if it is boiled once more, the result is a wax of the purest whiteness. Punic wax is also considered the best for medicinal preparations."

The above extract forms a small portion of the very

full historical account of beeswax given by Mr. T. W. Cowan in *Wax Craft—All about Beeswax,* published in 1908.

The early commercial importance of wax (i.e. beeswax) is shown by the fact that as long ago as 1483 the body now known as the Worshipful Company of Wax Chandlers, (quite distinct from the Company of the Tallow Chandlers, which is of equally ancient lineage), one of the oldest of the Livery Companies of the City of London, was incorporated by Royal Charter, "with power to choose a Master and two Wardens to oversee the craft of wax chandlery, and upon any defects or defaults being found, to punish the offenders."

Mr. Cowan's dedication of his book is of interest. It reads "To the Master, Wardens and Commonalty of the Art and Mystery of Wax Chandlers of the City of London, whose recorded history of five centuries exhibits its care for the interests and development of an important industry especially at a time when the candles used in the ritual of the Church were composed entirely of beeswax. The Master of this ancient guild being by virtue of his office President of the Bee-keepers' Association this work is dedicated in grateful acknowledgment by the Author." Further evidence that beeswax was the commodity with which the wax chandlers were primarily concerned is available. Their loving-cup, known as the Normansell Cup, made in 1563, "is engraved over the whole surface with subjects and articles relating to the production and manufacture of wax," including a man tingling and hiving a swarm of bees, another before a cauldron over a fire, a woman cutting cotton for wicks from a tree, a lighted candle, scissor-snuffers, etc. Their Beadle's staff-head, dated from about 1670, bears, below the Company's arms and motto, "a representation of a bee-hive and bees, illustrating the trade of wax-making."

The economic importance of bees, at first wild and later domesticated, as producers of honey and wax, was very great in Europe not only in classical times but until the much later period when cane sugar had ceased to be an expensive luxury. The sugar cane is native to the eastern tropics and only reached Egypt in the thirteenth century.

The beetroot did not become a commercial source of sugar until the days of Napoleon. Bee-keeping was thus carried on extensively, as it is in parts of Europe still, as the source of supply of a cheap sweetening substance. The alcoholic drink, mead, was made also from honey. These circumstances resulted in comparatively large quantities of the wax being produced. As sugar became available in large quantities from tropical countries the production of honey, and consequently of wax, declined.

Sources of Supply

To turn to the Empire trade in beeswax it will be seen from the appended statistics (Table I) that the United Kingdom is a large importer. No exact figures are obtainable to show how much beeswax is produced at home. That it is of relatively small amount is obvious because the home production of honey is small. The total consumption of honey in the United Kingdom is about 4 oz. per head per annum. The imports in recent years average rather less than 80,000 cwts., or a little over 3 oz. per head, leaving under 1 oz. per head for home production. Bee-keeping in the United Kingdom is thus a very minor industry compared with Canada and New Zealand, in both of which countries, although large exporters of honey, particularly Canada, the home consumption is placed at about 2 lb. per head per annum.

As there is a considerable demand for wax in the United Kingdom for various manufacturing purposes and this is not forthcoming from home production, beeswax has to be imported. As shown in Table I, the retained imports during the last three years have ranged between approximately 17,000 and 26,000 cwts. per annum. To the total imports (disregarding re-exports) Empire countries contributed about 15 per cent. in 1930, 18 per cent. in 1931, 31 per cent. in 1932 and 36 per cent. in 1933.

One point of great interest stands out prominently in considering the United Kingdom importations of honey and beeswax. It might reasonably have been anticipated that the countries which provide us with honey would also

furnish beeswax. This, however, is not the case, as is shown in the following statement of the values of honey and beeswax imported into the United Kingdom in 1933 from the principal Empire sources of supply.

	Honey.	Beeswax.
	£	£
Australia	6,944	—
New Zealand	21,758	—
Canada	45,111	—
British West Indies	18,534	549
British East Africa	—	24,848
Anglo-Egyptian Sudan	—	3,192
Nigeria	—	1,958
British India	—	3,665

Our Empire sources of beeswax are predominantly the tropical African territories, in which bee-keeping is not largely practised, and not Canada, New Zealand and the West Indies. Similarly with our foreign sources of supply. Only Russia and Chile send us both honey and beeswax in important quantities. The United States of America, and to a less degree Cuba and Guatemala send honey to the United Kingdom, whilst the chief foreign supplies of beeswax come from the French and Portuguese tropical African colonies, and smaller quantities from Abyssinia, Spain, Morocco and other countries.

The reason for this state of affairs is that the honey of commerce is mainly the produce of domesticated bees in temperate countries, whilst the beeswax is to a great extent obtained from wild bees in tropical or semi-tropical countries. Amongst Empire tropical countries, however, Jamaica stands out as a marked exception. During the last three years the value of the exports of honey from Jamaica has averaged about £12,000 per annum, whilst the corresponding figure for wax is only £500. Forty years ago the position was very different. Efforts were apparently made then to encourage wax production, the exports of which increased and reached a maximum in 1898. In that year 2,624 cwts. of honey valued at £2,124 were exported, and 1,590 cwts. of wax valued at £10,389. In 1933, when 13,566 cwts. of honey worth £11,643 were exported, the exports of wax were only 113 cwts., worth £512. The honey and wax exported in 1898 were obtained,

as at present, from domesticated and not wild bees. But in 1898 nearly 1,600 cwts. of wax could be exported with 2,600 cwts. of honey, whereas now, when the export of honey has so greatly increased, the export of wax has declined to an almost negligible amount. It may be that much more wax is used locally for industrial purposes, but no evidence of this has been observed. If not, then the question of making more profitable use of the wax seems worth attention. It might be of advantage to make wax a much more important product and limit the export of honey to the higher and more valuable grades.

When attention is concentrated on securing the maximum honey production, using modern methods, the amount of surplus wax is comparatively small. In the first place, to relieve the bees of the necessity of having to use up a large amount of honey in making all the wax they require, they are provided with wax comb-foundation. Then, in the modern process of extracting honey, it is only necessary to remove the wax capping from the cells. The emptied honeycomb can be put back in the hives to be refilled. The result is that the wax produced is mainly that obtained from the cappings, brood comb and finally discarded honeycomb.

From Table I, giving the sources of the imports of beeswax into the United Kingdom, it is apparent that the supplies received from Empire countries, although recently they have increased rapidly, are still small compared with those from foreign countries. This is not due to the Empire production being so small that it is not sufficient to meet the demand in the United Kingdom, but because, with the exception of Jamaica and the Gambia, which send all or practically all their small output to the United Kingdom, the wax is largely marketed elsewhere.

This is clearly seen by an examination of the figures in Table II of the direction of trade from the principal Empire producing countries. Kenya and Uganda, with a total export of 954 cwts. in 1933, sent only 40 cwts. or 4·2 per cent. to the United Kingdom. In the same year Nyasaland exported to the United Kingdom 87 cwts. or 36 per cent. of a total of 241 cwts. Tanganyika, which exports a large quantity of beeswax, sent in 1933 to the United

Kingdom 5,840 cwts. or 43 per cent. of the total of 13,600 cwts., a much larger proportion than in 1931, when from a total of about the same magnitude, 12,143 cwts., only 2,510 cwts. or 21 per cent. came to the United Kingdom.

The small output of wax from the Gambia in 1933 and the two previous years was all exported to the United Kingdom.

From British India, another large producing territory, the United Kingdom received in 1933 only 705 cwts., or 6 per cent. of the 11,645 cwts. of beeswax exported ; in 1932 the proportion was about 8 per cent., and in 1931 only 2·5 per cent.

The exports of beeswax for 1933 of the seven Empire producing countries given in Table II may be grouped thus :

	cwts.
Total exports	26,653
To the United Kingdom	6,883
To other British Empire countries	1,056
To foreign countries	18,714

There would seem to be an opportunity for these Empire countries to develop their production of beeswax to meet, to a greater extent, the demand in the United Kingdom, preferably, if possible, without sacrificing markets already won elsewhere.

In order to do this it appears in the first place necessary to take steps to study the requirements of the United Kingdom market. Enquiries made in the trade recently elicited the opinion that the reasons for the greater import of foreign beeswax are principally its better sorting into grades distinguished by colours (white, yellow or dark yellow), the greater uniformity of particular grades, and the method of packing in one-hundredweight bales. The following observations include criticisms made on beeswax from various Empire sources.

India.—Indian beeswax compares unfavourably with that from foreign sources. This is partly due to the fact that the pure beeswax itself is of somewhat different composition from that of other countries, and partly to faulty preparation and adulteration with paraffin wax and other substances. It has shown some improvement

in the latter respects in recent years. A report on authentic samples of Indian beeswax was published in this BULLETIN (1922, **20**, 155).

Tanganyika.—The grades known as "Dar-es-Salaam" and "Tanganyika" are very good, but mixed in colour, and are shipped in lumps and slabs of irregular size. These two waxes generally command a good price.

Zanzibar.—A very good wax, but only small quantities come on the market.

Gambia.—The former export trade (550 cwts. in 1909) decreased after 1921, in which year the melting of beeswax was declared an "obnoxious trade" by the Public Health Department. In 1929 samples sent to the Imperial Institute were reported on as being of good quality. Steps have recently been taken to revive the industry, by preparing the wax in an inoffensive manner.

Jamaica.—Excellent, though always mixed in colour.

South Africa.—Described as a nice wax, but very little has been imported in recent years.

Australia.—Only small quantities come to the United Kingdom of a very good quality of refined wax, well packed, but the price is too high for buyers in this country, who prefer to refine the wax themselves. The production of wax in Australia has decreased with the more general use of frame hives and the imports now exceed the exports.

New Zealand.—The position is much the same as in Australia.

The Marketing of Beeswax

In order to market beeswax to the best advantage the following points should be noted. The principal requirements of a good beeswax are that it should be of good colour, clean in appearance, free from dross (dead bees, etc.), and pure (unadulterated). Hard beeswaxes are preferred.

Good beeswax is of an orange, or golden-yellow to lemon-yellow colour, and, other things being equal, lighter coloured samples are generally more highly valued. It is not possible to draw up a scale of grades corresponding to colours, nor is it expected that beeswaxes from different countries should be identical in characteristics. What is

more important is that the product obtained from any particular source should be of uniform quality, so that purchasers can rely on getting what they require. Such uniformity, coupled with regularity of packing, is stated by a leading firm of importers to be worth a premium of about £5 per ton.

The following is a simple and effective method of cleaning beeswax, i.e. of freeing it from various impurities. The crude wax is melted, preferably by steam heat, in a large double-jacketed tank or pan. The use of direct heat may involve the risk of darkening the wax and also of its catching fire.

The solid impurities, together with any remaining liquid matter, such as honey or water, go to the bottom of the vessel, whilst the wax floats on the top and on being allowed to cool solidifies into a solid block which merely requires the lower surface to be scraped to render it ready for market. These scrapings can be remelted with the next lot of crude wax. This method is more effective than skimming off the liquid wax.

To attain uniformity for export, wax from different centres received at the port of shipment can be well mixed, re-melted and cast into blocks of a regular size. The actual size of the blocks is not of great importance, so long as they are not too heavy, e.g. they may be, say, 10 lb., 14 lb. or even 25 lb.

Bleaching Beeswax

For certain purposes, e.g. the manufacture of candles, it is necessary for beeswax to be white. The bleaching can be effected by the sun or by chemical means. Sun bleaching is the more satisfactory method, but can only be used where the sun's rays are sufficiently powerful, as in the tropics and southern Europe. In this process the wax is first purified by remelting in hot water to remove all traces of honey and other soluble impurities. The wax is then " shredded " by melting it and running thin streams of the molten wax over a revolving cylinder partially immersed in cold water. The wax solidifies in thin ribbons or shreds. These ribbons are exposed to the sun on canvas

sheets stretched over wooden frames. Water is often sprinkled over them to minimise sticking, and they are frequently turned to expose fresh surfaces. To accelerate thorough bleaching, which only takes place on the surface, the wax may be melted again and re-formed into fresh ribbons. The time taken in the bleaching process is dependent on the intensity of the sunshine and may be two or three weeks, or longer.

Beeswax can be bleached chemically by the use of various oxidising agents, such as hydrogen peroxide and chromic acid. To bleach by the action of chromic acid, the wax is melted and boiled in a lead-lined vessel with a solution of potassium dichromate and sulphuric acid. The solidified wax resulting from this operation is green, owing to residual traces of chromium salts. These can be removed by remelting and boiling with dilute oxalic or sulphuric acid. Such chemically bleached beeswaxes are not suitable for all purposes.

Uses

Unrefined beeswax is used in the manufacture of furniture and floor polishes and pastes, preparations for dressing and waterproofing leather goods, such as boots and harness, and for grafting, sealing and sewing waxes, etc. The preparation of wax comb-foundation to which reference has already been made is also important.

Refined beeswax enters into the composition of many cosmetics, ointments and other preparations. It is used also for encaustic paints, lithographic and other special inks, and for modelling flowers, fruits and anatomical and other exhibits. The refined wax is still used largely for the manufacture of church candles. The Ministry of Agriculture and Fisheries (*Report on the Marketing of Honey and Beeswax*, 1931) states that " since 1907, makers of beeswax candles have been obliged by the ecclesiastical authorities to guarantee the percentage of beeswax in the candle. The percentage of beeswax has to be stamped on the butt end of the candle. The usual grades sold are guaranteed to contain respectively 95, 75, 65, 55 and 25 per cent. of genuine beeswax."

TABLE I

IMPORTS OF BEESWAX INTO THE UNITED KINGDOM

From	Quantity (cwts.).			Value (£).		
	1931.	1932.	1933.	1931.	1932.	1933.
U.S.S.R. (Russia)	941	—	218	5,870	—	412
Belgium	380	1,082	1,865	2,122	4,276	7,319
Belgian Congo (Inc. Ruanda and Urandi)	145	60	1,681	1,015	231	6,310
Germany	761	348	413	3,934	1,651	2,039
Netherlands	523	286	—	2,041	1,247	—
France	3,431	1,674	1,557	21,195	10,208	8,762
French West and Equatorial Africa	3,357	1,337	1,478	16,090	5,376	5,626
French Somaliland	597	1,292	1,777	3,411	5,162	7,081
Madagascar	429	165	409	2,232	71	1,539
Portugal	6,108	1,133	3,217	29,385	4,67[illegible]	12,831
Portuguese West Africa	1,731	1,165	318	8,137	4,[illegible]39	1,211
Portuguese East Africa	702	336	79	3,733	1,011	303
Spain	155	689	198	806	3,812	1,077
Egypt	252	571	266	1,345	2,207	1,436
Morocco	211	—	—	1,069	—	—
Abyssinia	1,293	1,853	325	7,258	6,866	1,290
Chile	633	635	181	4,217	3,105	924
Brazil	(a)	(a)	100	(a)	(a)	333
United States of America	578	146	385	3,690	1,441	3,535
Other foreign countries	514	657	250	2,607	2,494	1,047
Total from foreign countries	22,741	13,429	14,717	120,157	59,312	63,075
British East Africa	2,891	2,389	5,802	13,008	10,995	24,848
Nigeria	162	150	492	803	592	1,958
Anglo-Egyptian Sudan	1,070	2,269	799	4,801	8,776	3,192
Jamaica	45	123	114	255	690	549
British India	337	518	783	1,927	2,687	3,665
Other British Empire	381	671	362	1,941	3,235	1,361
Total from British Empire	4,886	6,120	8,352	22,735	26,975	35,573
Total	27,627	19,549	23,069	142,892	86,287	98,648
RE-EXPORTS TO:						
Germany	548	51	25	2,642	247	157
Denmark (inc. Faroe Is.)	(a)	(a)	222	(a)	(a)	1,295
France	(a)	(a)	100	(a)	(a)	589
United States of America	286	987	2	1,322	5,422	11
Other foreign countries	414	480	160	2,090	2,266	1,052
Total to foreign countries	1,248	1,518	509	6,054	7,935	3,104
Australia	(a)	(a)	256	(a)	(a)	1,536
Irish Free State	(a)	(a)	242	(a)	(a)	1,093
Union of South Africa	(a)	(a)	126	(a)	(a)	640
Other British Empire	747	899	115	4,349	4,803	742
Total to British Empire	747	899	739	4,349	4,803	4,011
Total	1,995	2,417	1,248	10,403	12,738	7,115

(a) *Included, if any, with "Other foreign countries" or "Other British Empire."*

TABLE II

EXPORTS OF BEESWAX FROM EMPIRE COUNTRIES (DOMESTIC PRODUCE)

Particulars of countries.	Quantity (cwts.).			Value (£).		
	1931.	1932.	1933.	1931.	1932.	1933.
Kenya and Uganda:						
Total	1,130	1,050	954	4,518	4,129	3,935
To United Kingdom	—	73	40	—	259	160
Other British Empire	—	35	—	—	123	—
France	80	51	40	320	205	160
Germany	488	791	274	1,948	3,142	1,085
Belgium-Luxemburg E.U.	342	—	140	1,370	—	560
Netherlands	—	100	300	—	400	1,250
United States	220	—	160	880	—	720
Nyasaland:						
Total	195	170	241	1,092	953	1,348
To United Kingdom	127	119	87	710	665	487
Germany	68	51	154	382	288	861
Tanganyika:						
Total	12,143	7,820	13,600	47,010	31,965	52,751
To United Kingdom	2,510	2,120	5,840	8,929	8,021	22,075
Other British Empire	1,090	480	180	3,801	1,825	620
France	1,502	720	300	5,513	2,976	1,225
Germany	2,807	1,780	3,760	11,567	7,882	15,246
Belgium-Luxemburg E.U.	1,805	740	860	7,392	3,200	3,326
Netherlands	1,629	820	640	6,650	3,374	2,544
United States	662	1,080	1,820	2,685	4,313	6,965
Other Foreign Countries	138	80	200	473	374	750
Gambia (*a*):						
Total, all to— United Kingdom	104	368	99	344	1,254	272
Union of South Africa:						
Total, all to— United Kingdom	—	1	1	—	3	3
Jamaica:						
Total	70	141	113	343	652	512
To United Kingdom	70	141	111	343	652	498
Other countries	—	—	2	—	—	14
British India (*b*) (*c*):						
Total	15,466	4,497	11,645	30,059	10,880	22,877
To United Kingdom	381	383	705	2,441	2,080	3,919
British Malaya	399	60	134	1,851	299	534
Union of South Africa	—	103	(*d*)	—	161	(*d*)
Other British Empire	496	944	742	1,731	3,613	2,250
Continent of Europe	—	6	60	—	19	219
Japan	14,189	3,000	9,969	24,002	4,705	15,797
Other foreign countries	1	1	35	34	3	158

(*a*) *Recorded under general heading "waxes."*

(*b*) *Years ended March* 31, 1931, 1932, 1933. *The exports during the year* 1933–4 *amounted to* 1,491 *cwts., valued at* £5,403.

(*c*) *Recorded under general heading "waxes of all kinds, other than paraffin wax (excluding candles)."*

(*d*) *Included, if any, with "Other British Empire."*

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils and Manures

Nigeria.—The following statements are contained in the Report of the Chemical Section at Ibadan for the period July–December 1934, by H. C. Doyne, Senior Agricultural Chemist.

Liming Experiments at Umuahia.—The lime status of soils dressed with 10, 20 and 80 cwts. of lime per acre is maintained after three years cropping under an annual rainfall of 90–100 inches. The latest figures for *p*H values (November sampling) show for the control plots 4·0–4·2, for the 10-cwt. limed plots 4·8–5·2, for the 20-cwt. limed plots 5·8–6·2 and for the 80-cwt. limed plots 7·0–8·3. The nitrogen and the available phosphate contents are generally appreciably lower for the 80-cwt. dressed plots than those for the adjacent controls.

Plots which were treated in 1931 with variations of sulphate of ammonia, steamed bone flour and sulphate of potash, both limed and unlimed, show superior yields for the unlimed plots except where the phosphate treatment has been omitted and also where no artificials had been applied. There was a definite drop in nitrogen content for the limed plots, but where phosphate had been applied the liming had increased its availability.

Pot Experiments.—A very acid soil (*p*H 3·8) was used for crop germination experiments. One set of soils was thoroughly mixed with lime water and its *p*H raised to 4·7 and the other set was left untreated and made up to the same moisture content. Seeds of maize, popondo, *Tephrosia candida*, *Calopogonium mucunoides*, *Mucuna utilis*, Crotalaria, Centrosema and Mimosa were sown. In every instance the germination on the unlimed soils was equal to or superior to that on the limed soils. So that the failure of many of these crops on an acid soil cannot be accounted for by poor germination.

A further experiment is in progress, using the same acid soil with and without lime (at 30 cwts. per acre), rock phosphate (at 6 cwts. per acre) and green manure.

Green Manuring Experiments at Moor Plantation.—The results given in the last report (this Bulletin, 1934, **32,**

437) have now been amplified by finding a direct correlation between the yields and the nitrogen content. Nitrate determination, however, showed definite depressions for the "burnt" and "carried off" plots. Exchangeable ammonium showed no agreement with either treatments or yields. Available phosphorus was generally higher on the burnt plots. Samples taken in November after the rains showed a loss in nitrogen, exchangeable bases and available phosphorus, but the relative contents of the different plots remained much the same.

The maintenance of carbon and nitrogen and the seasonal changes which take place in cropped and bush soils are being investigated. Three small plots are kept entirely free from weeds and are sampled at monthly intervals; the results are compared with samples from three similar plots which are kept untouched and carry mainly coarse grass. Up to the present it has been found that there is a drop in carbon and nitrogen contents during the rains which is more marked on the clean weeded than the untouched plots. *p*H and exchangeable base contents do not show any definite variations.

Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, reports as follows:

The manuring experiment referred to in my last report as Experiment B has been repeated on the same plots as last year. A further application of manures was made in the spring and a crop of guinea corn was grown. The results are substantially the same as with cotton in the previous season, i.e. a mixture of nitrate of soda, superphosphate and muriate of potash containing nutrients equivalent to 1 ton of farmyard manure gives a better yield than 1 ton of farmyard manure and as good a yield as two tons. Also, one ton of farmyard manure gives as good a yield as two tons, if superphosphate and potash equivalent to the second ton of manure are added. The results are as follows:

Treatment.	Yields in lb. per acre.	
	Grain.	Leaves.
1 ton farmyard manure (F.Y.M.)	727	678
Artificials equivalent to 1 ton F.Y.M.	1,037	918
2 tons F.Y.M.	1,037	922
1 ton F.Y.M. + superphosphate and potash equivalent to 1 ton F.Y.M.	1,171	906
Artificials equivalent to 2 tons F.Y.M.	1,457	1,200
Standard error	± 77·1	± 92·5

The crop on most of the unmanured plots failed owing to a locust attack from which the more vigorous plants on the manured plots were able to recover.

Work is again in progress on ground-nuts and silage, but no results are at present available.

Insect Pests

Locusts

Nigeria.—Mr. J. D. Golding, Senior Entomologist, in his report on the work of the Entomological Section, Nigerian Agricultural Department, for the period July 1 to December 31, 1934, states that Mr. A. M. Gwynn continued the ecological investigations near Lake Chad between July 1 and late October. At the end of this period he visited parts of the Dikwa Division to the south of the lake and found scattered adults of the Red Locust to the east of Dikwa, and in several other localities between that town and Chad. The presence of *Nomadacris* in an area more than thirty miles from Chad is of great interest, as, previously, this species was thought to be confined to the lake shore.

Mr. Gwynn observed that there was a remarkable decrease in the number of *Nomadacris* adults before breeding took place and that breeding itself was largely unsuccessful. The result of this was a complete reversion to the solitary phase throughout the British Chad region.

Mr. Gwynn believes that the solitary phase of the Migratory Locust is more at home in habitats away from the lake, or at least not subject to flooding; but he considers that it is reasonably certain that conditions in the Chad area are nowhere suitable for the independent development of phase *gregaria*.

In September Mr. Golding attended the Third International Locust Conference in London; in one of the resolutions the opinion was expressed that it was desirable for the distribution of *Nomadacris* to be determined along the shore of Chad lying in French territory to the east of Nigeria. It is proposed that Mr. Golding and a French entomologist should make a joint examination of this area in May 1935. This survey should yield interesting results as it now seems probable that southern British Chad is merely the western limit of the range of *Nomadacris*.

The monthly maps showing the movements of swarms of the Migratory Locust in Nigeria since the beginning of the outbreak in December 1929, have been brought up to date and a large number of meteorological data are being

collected and analysed. The object of this research is to determine the effect of various climatic factors upon the movement of swarms.

Beverages

Cocoa

Nigeria.—The following account of work carried out by Mr. O. J. Voelcker is contained in the report of the Botanical Section, Southern Provinces, for the period July to December 1934.

Seasonal Influence on Weight of Beans.—The weight of bean is a factor which is taken into consideration in grading cocoa in Nigeria, and regulations are in force to limit grade I to such parcels of which a sample of 300 beans weighs eleven ounces or more. Although cocoa may be harvested throughout the year there is a marked main-season crop which usually commences in September and ceases abruptly in January. Cocoa harvested outside this period is known as the Easter crop, mid-season crop, or collectively, out-of-season crop, and is generally inferior in quality. The Easter crop is characterised by small light beans, and it has been found in practice that this crop is excluded from grade I cocoa by the eleven-ounce limit. The mid-crop is produced during the rainy season, and parcels are found frequently to contain a percentage of mouldy beans.

The experimental cocoa plots growing on Moor Plantation, Ibadan, are harvested every three weeks. In order to gain information on the variation in weight of bean throughout the year, 1,000 dry fermented beans were weighed from each harvest. The figures given on page 65 show the period of delivery of the crop and the weight of beans from a plot of 2·2 acres of yellow-pod Forastero cocoa between March 1933 and March 1934.

It will be noticed that the two harvests in January 1934, although part of the main season, failed to reach grade 1 requirements. This is thought to be due to severe Harmattan which occurred during that period, and which, on account of the very dry atmosphere associated with it, is known to decrease the moisture content of cocoa beans below the normal limit designated as commercially dry.

The Ibadan Native Administration Cocoa Farm.—Cocoa is the most important and profitable export crop of the Ibadan people, but there are many factors influencing yield which are at present not fully understood. Such factors include the spacing distances at which the trees are planted, the genetical strain grown, the incidence and control of

Date harvested.	Total wt. of wet beans in lb.	Wt. of 1,000 dry, fermented beans in ounces.
March 16, 1933	38	27·75
April 6, 1933	68	29·5
April 28, 1933	168	31·75
May 19, 1933	38	29·75
June 8, 1933	2	—
June 28, 1933	17	31·75
July 20, 1933	174	38·5 [1]
August 10, 1933	220	37·25 [1]
August 31, 1933	230	43·5 [1]
September 22, 1933	260	46·5 [1]
October 12, 1933	133	46·75 [1]
November 3, 1933	485	44·0 [1]
November 24, 1933	977	40·25 [1]
December 19, 1933	922	38·75 [1]
January 5, 1934	506	33·25
January 26, 1934	122	32·25
February 16, 1934	9	32·0
March 7, 1934	12	31·35

[1] *Passes Grade I requirements. For* 1,000 *beans the weight must not be less than* 36·67 *oz.*

diseases and the use of permanent shade. Unfortunately, experimental plots to investigate these points cannot be laid down on the Department's farm at Moor Plantation, Ibadan, owing to the absence of suitable land, and it was found essential to obtain the lease of some other area if these investigations were to be carried out. The Ibadan Native Administration were approached, and their whole-hearted assistance has rendered possible the loan of thirty acres of land which, though situated just within a forest reserve, lies in the cocoa belt. The Native Administration further offered to bear the cost of establishing and maintaining this farm, and their willingness to do so in times of intense depression reflects their long-sighted policy.

The site was cleared during the 1933–34 dry season, and the layout of the farm was arranged as follows. Ten one-acre plots of 121 × 40 yards were marked out with their long borders adjacent. Of these plots nine are utilised as a spacing experiment with cocoa stands at 15 × 15 ft., 12 × 12 ft. and 8 × 8 ft. square planting. The tenth plot is 8 × 8 ft. and is to form an area of cocoa on which thinning and mycological experiments can be carried out. These ten plots are replicated in another block through which permanent shade is to be grown.

Temporary shade of early maize, bananas, Tephrosia, Crotalaria and cassava has been established in all plots as it has been found by experience that ample shade is necessary for young cocoa. Seedlings raised from self-fertilised seed from selected trees at Moor Plantation were planted out during June and July 1934, and though losses have occurred, the establishment of the cocoa is considered to be proceeding satisfactorily.

Mr. J. West, in his section of the Botanists' Report, quotes Mr. O. J. Voelcker's statement that "the Department of Agriculture recognises that, for Nigerian cocoa, 100 pods average 86 lb. yielding 20 lb. of wet cocoa." He points out that ("Initial Cocoa Selection in Nigeria," *Eleventh Ann. Bull., Dept. Agric., Nigeria*) these figures apply to the main-season crop, and that it is of interest that the truth of this statement has been borne out by the records obtained from the Ajia plots, where methods of disease control are being tried. The figures for the Ajia plots, which include both healthy and diseased pods and beans, for the period 1931–34 are as follows :

Main Season—three crops included.
93,283 pods gave 18,880·5 lb. wet cocoa.
i.e. 100 pods = 20·2 lb. wet cocoa.
Mid Season—three crops included.
31,208 pods gave 5,231·75 lb. wet cocoa.
i.e. 100 pods = 16·8 lb. wet cocoa.
All Season—six crops included.
124,491 pods gave 24,112·25 lb. wet cocoa.
i.e. 100 pods = 19·4 lb. wet cocoa.

H. C. Doyne, Senior Agricultural Chemist, Southern Provinces, in a report on work carried out on cocoa soils, states that the die-back of cocoa can in part be attributed to the presence of a hard concretion layer within the range of the root system. A further cause is possibly due to a rapid increase in acidity with depth which in fact is probably an earlier stage of the concretion formation. Profile studies, therefore, give a strong indication as to where cocoa may be expected to fail, a few years after planting. No agreement between the carbon-nitrogen ratio and fertility occurs in Nigerian soils, and the increase in specific conductivity of a soil-water suspension after seven days' standing gives no indication of the suitability or otherwise of a Nigerian soil for cocoa.

J. D. Golding, Senior Entomologist, reports that examinations of railway wagons, cocoa stores and drying platforms have been made with the objects of ascertaining at which points the beans are infested and of establishing the identity of the local Cocoa Moth. So far only *Ephestia cautella*, Wlk., has been found ; this is of interest, as the principal pest of cocoa in English warehouses is *Ephestia elutella*, Hb. It has been said that the infestation of warehouses is due to insects arriving in beans from the various cocoa-exporting countries.

CEREALS

Guinea Corn

Nigeria.—In his report for the period July–December 1934, Mr. J. West, Botanical Section, Southern Provinces, states that through the courtesy of the Director of Agriculture, Sierra Leone, a sample of a guinea corn variety which tolerates a heavy rainfall was obtained. The seed was sufficient to plant a one-twentieth acre plot. Sown about the middle of June, in the height of the rains, the crop was harvested five and a half months later in the dry season. The yield of threshed grain obtained was equivalent to some 1,270 lb. to the acre. This compares very favourably with previous yields of about 600 lb., which other varieties have given at Ibadan. A certain amount of variation was shown in the crop, both as regards time to maturity and the colour of seed and glumes. It is hoped to fix a suitable strain by mass selection.

Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports that the Farafara strain (FB), which was found to have "degenerated" (become mixed), was discarded in 1933 and selected derivatives of it and a sister strain (FA) were tested in 1934. The old farm standard Farafara was also discarded as being no longer typical of the guinea corn grown in the district and fresh seed was obtained from various native farmers living within fifteen miles of the experimental farm. Along with the FB and FA derivatives a new Farafara selection (AF_2) was tested. The trial was conducted on one-eighth acre plots with the local mixture planted on the alternate plots. The result was as follows:

Average yield of grain per acre of 31 plots Local Mixture:—768 lb.

	Yield of grain as per cent. of local mixture.	Threshing. Per cent.
Local Mixture	100	68
AF_2	138	76
AF_{28}	124	76
AF_{43}	120	76
AF_{49}	107	70
AF_{52}	115	72
AF_{54}	97	73

AF_{28}, AF_{52} and AF_{54} are FB derivatives.
AF_{43} and AF_{49} are FA derivatives.

There were five plots of each of the varieties. All the differences were significant except that between AF_{54} and the standard. AF_{49} was badly affected by grain smut and AF_{43} rather less so. It is doubtful whether

this means greater susceptibility, as some smut spores got loose in the laboratory during the examination of the 1933 strains and these two may have been more heavily infected than the others. At one time AF_{49} looked likely to yield best in this trial.

Legumes

Cowpeas

Nigeria.—Dealing with investigations carried out during the period July–December 1934, Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports that in 1930 Nseuca Cowpea was introduced from Nyasaland and has shown considerable promise in Northern Nigeria. The seed as first introduced was reddish, but it soon became mixed with purple and pale grey, presumably through hybridisation with the local white variety. By selection and isolation the red-seeded variety has been recovered and a new grey-seeded variety obtained. All the purple-seeded types were discarded.

In 1934 the new grey-seeded strain was tested against the local white-seeded variety. The trial was interplanted in Gero (*Pennisetum typhoideum*).

The results were as follows :

	Threshed seed
Average yield of 9 plots local white variety . . .	237 lb. per acre
Average difference of 8 plots Nyasaland variety . .	-53 ± 21

This is a decrease of 22 per cent.

The picking of pods was finished at the end of November, by which time the local variety had died, so that the yield of harawa (foliage and edible portions of the stem cut for fodder) was as follows :

Local white	nil
Nyasaland	604 lb. per acre

This strain will be tried again along with the red-seeded strain.

Root Crops

Cassava

Nigeria.—Mr. J. West, Botanical Section, Southern Provinces, in his report for the period July–December 1934, states that to a large extent work with cassava is concerned with the breeding of types which will be immune or resistant to the mosaic disease. Of the Nigerian cassavas, none have been found immune. Five of the

sweet varieties have shown resistance, but all the bitter varieties have proved to be susceptible. Two varieties introduced from Sierra Leone and one from the Gold Coast have proved resistant, while of six varieties obtained from Trinidad, one has so far proved susceptible.

An attempt is being made to hybridise the main local types with resistant varieties, with the object of combining tuber quality and yield with mosaic resistance. The work is complicated partly because the percentage of artificially pollinated flowers which set seed is extremely low, and partly because a number of cassava types have not yet flowered at Ibadan, even though left in the ground for a period of two years. Furthermore, while some of the flowering types produce both male and female flowers, others produce female flowers only. The time of flowering varies very considerably, but preliminary experiments suggest that cassava pollen will store in desiccators for several months.

Through the courtesy of the respective Directors of Agriculture, the following varieties have been introduced into Nigeria :

Gold Coast : two varieties, one of which died out.

Sierra Leone : Mayugbe and Two Cent.

Trinidad : Parasol, Maman l'Enfant, Sellier, Turkey Claw, White Stick and Black Stick.

Yams

Nigeria.—Mr. West, in the same report, makes the following reference to the work on yams.

As mentioned in previous reports, a collection of Nigerian yam varieties is being studied on Moor Plantation. The collection contains the following samples :

Dioscorea alata : 36 samples.
D. bulbifera : 2 samples.
D. cayenensis : 129 samples.
D. dumetorum : 9 samples.
D. rotundata : 29 samples.

Of these, 117 samples had been multiplied sufficiently for field tests to be carried out regarding the effect of staking and non-staking on yield. The results showed that, with three exceptions, the effect of non-staking was to reduce the yield by from one-third to one-half. After harvest, five tubers from each sample were selected for a storage test under native conditions. These experiments are being repeated in greater detail this year.

Fruits

Citrus

Nigeria.—According to the report of Mr. E. H. G. Smith, Botanical Section, Southern Provinces, for the period July–December 1934, the multiplication and trial of the new citrus varieties has been continued. During the past six months material of the Temple and Satsuma oranges was successfully introduced from Florida. Local reproduction of the new varieties is in progress at Moor Plantation, and the planting of local buddings at other experiment stations has begun. The trees planted out at Moor Plantation and Agege during 1932 and 1933 are growing well, and losses have been negligible.

The report by Mr. J. West of the same Section contains the following account of investigations carried out on citrus diseases.

In the past, the most common disease of citrus in Nigeria has been a foot rot or Gummosis, the cause of which has not yet been determined. The prevalence of this disease is probably due to the previous use of Lime stocks. Recently the Department has been concerned with the introduction of commercially important citrus types from abroad and with the laying down of stock trials at the out-stations. It is hoped that, in the Southern Provinces, by budding on Sour Orange stocks, Gummosis may be eliminated.

In 1934, Scab (*Sporotrichum citri*) broke out severely on Sour Orange seedlings at Ibadan. This is the first record of the disease in Nigeria, but it is possible that, although present previously, it did not become apparent until the laying down of the extensive citrus nursery on Moor Plantation. So far, Scab has not become serious on trees planted out in the field. The disease was checked in the nursery by Bordeaux Mixture sprays and by the cutting off and burning of infected material. The shade methods adopted by Briton-Jones in Trinidad are now being tried out. ("The Control of Scab in the West Indies," *Trop. Agric., West Indies*, 1933, **10**, 40.)

At Agege, some sixteen miles from Lagos, the citrus stock trials occupy land formerly under Hevea rubber. The block was known to be very heavily infested by *Fomes lignosus*. When the block was cleared in 1931–32, the rubber trees were cut and burnt, and the land was very thoroughly stumped. During the past season, however, three cases of root disease of citrus occurred,

caused by *F. lignosus*. The root stocks involved were Grapefruit, Hybrid Lemon and Acid Lime.

A branch canker of Grapefruit has appeared at Agege, with which a *Diplodia* sp. is associated. The disease does not, however, appear to be serious, and is confined to one variety of Grapefruit.

Pathological observations are being maintained on all the new citrus plantings, since it is quite possible that diseases may prove to be the limiting factor in the development of a citrus industry in Nigeria.

Spices

Chillies

Nigeria.—The following account of investigations on chillies is contained in the report for the period July–December 1934, furnished by Mr. O. J. Voelcker, Botanical Section, Southern Provinces.

Chillies are grown as a compound crop throughout Nigeria, where the fruits are used either for seasoning food or as a vegetable. The collection of chillies grown at Ibadan and mentioned in previous reports showed a great diversity of fruit form, and it was hoped that several of these might find a market outside the country. There is little doubt that production of chillies would increase rapidly, given a reasonable price ; and as the fruit requires no " processing," other than drying, before export, the crop would appear suitable for native production.

Progeny from fourteen single-plant selections were grown in 1933 with the object of obtaining samples for testing the market. At the same time data were collected on yield, general habit and resistance to disease. These samples were representative of types usually grown for seasoning purposes. Those which are locally used as fresh vegetables were not included, as these on drying lose their colour or become blotchy ; there is also a considerable danger of mould. Out of the fourteen selections three were chosen for their high yield and general appearance, two for their reputed spiciness and one for the cherry shape of the fruit. Samples of these six were sent to the Imperial Institute. A valuable and comprehensive report received from the Institute giving commercial opinions has made it clear that none of the samples was of an attractive enough appearance to interest buyers. In all the samples the colour was too light and the skin too wrinkled to meet the demand for pickling or grinding ; one sample, however, was promising on account of its pungency and possible use in pharmacy.

It is probable that the colour and shrivelling of the fruit are influenced by the rate at which they are dried and the length of time over which they are stored, but there is little doubt that these factors alone could not make all the difference in appearance between Nigerian and the highly-priced Japanese chillies. From the Imperial Institute report on these Nigerian samples it appears that an exacting market is prepared to pay high prices for chillies of the best appearance, but that second-grade fruits can find no market at all, even at greatly reduced prices.

Work during 1934 was confined to growing a small isolated plot of the variety which showed promise for pharmaceutical purposes. This variety is by no means pure and all off-type plants were pulled up as soon as fruit form became apparent. Chillies cross-pollinate readily and the mass selection adopted here is thought to be the most practical method of attaining and, later, maintaining purity.

In 1933, each of the different types of chillies originally collected by the officers of the Department in charge of Agricultural stations was planted. The collection was thus representative of types grown throughout the Northern and Southern Provinces and of the Cameroons. Data on vegetative characters were collected for some ninety varieties, and pressed specimens, together with dried fruit from these, were obtained. The value of the collection was enhanced by covering notes which were forwarded by the Agricultural Officers, giving local names, uses and methods of cultivation.

It is now generally recognised that there are only two species of chillies, *Capsicum frutescens* and *C. annuum*, but that within these species there is a great range of varieties. In order to assist the classification of these varieties the collection was sent to Kew, and their willingness to undertake this identification is greatly appreciated.

Oil Seeds

Ground-nuts

Nigeria.—Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, reports as follows with regard to investigations carried out during the period July–December 1934.

At Zaria.—The selected strain of erect ground-nuts, Castle Cary, which had yielded 24 per cent. higher than the Standard erect type in three years of trial, has for the past two seasons yielded exactly the same amount of nuts as

the Standard, though it has maintained its superiority in yield of tops. This applies only to the trials carried out on the main farm. The figures for the last four years are as follows :

		Kernels per acre.
1931.	Average yield of 13 plots Standard	701 lb.
	Average difference of 4 plots Castle Cary . . .	$+ 188 \pm 48$
1932.	Average yield of 35 plots Standard	281 lb.
	Average difference of 6 plots Castle Cary . . .	$+ 89 \pm 19$
1933.	Average yield of 12 plots Standard	575 lb.
	Average difference of 12 plots Castle Cary . . .	$- 4 \pm 25$
1934.	Average yield of 13 plots Standard	579 lb.
	Average difference of 6 plots Castle Cary . . .	$- 6 \pm 35$

In small-scale trials on another type of soil the results were as follows :

		Yield of Standard kernels, lb. per acre.
1930.	Castle Cary gave 15 per cent. higher yield than Standard	603
1931.	Castle Cary gave 6 per cent. lower yield than Standard	1,315
1933.	Castle Cary gave 10 per cent. higher yield than Standard	708
1934.	Two trials :	
(1)	Castle Cary gave 10 per cent. higher yield than Standard	791
(2)	Castle Cary gave 16 per cent. higher yield than Standard	806

The Standard is the local upright variety in every case. This strain has been tried at several other stations in the Northern Provinces this year, but the results are not yet available, except in part from Kano.

At Kano.—In two small trials at Kano in 1934 one on one-eighth acre plots and the other on one-fiftieth acre plots the selected upright variety (C.C.) was 12 and 13 per cent. better than the standard spreading variety. In the second trial the difference was significant. In a similar trial in 1933, C.C. was 18 per cent. better than Standard, but in a larger trial was found to yield 7 per cent. less than the selected spreading variety S.C. As the difference was small the trial is being repeated, since, other things being equal, an upright variety is preferred to a spreading variety. Until recent years it has been assumed that any upright variety would give a much inferior yield to the spreading variety at Kano.

The two selected spreading strains (S.C. and P.R.) have been tested for the past five years at Kano and each has averaged 8 per cent. better than the Standard. In one yield trial only out of ten (and this on very wet land) were these two strains beaten by Standard, P.R. being 30 per cent. down and S.C. 9 per cent.

Oil Palm

Nigeria.—The report furnished by the Botanical Section, Southern Provinces, for the period July–Decem-

ber 1934, contains the following account of work carried out by Mr. E. H. G. Smith on oil palm selection.

Additional areas of the first generation of the Calabar oil palm selections were established during the 1934 rains. The object of this recent planting was to increase the proportions of mantled palms, and of all the thin-shell forms. Since 1930, when planting was begun, the following acreages have been established :

Year.	Acreage.	Experiment stations.
1930	15½	Benin and Umuahia
1931	26½ [1]	Ibadan and Onitsha
1932	2½	Benin
1933	2¼	Ibadan and Agege
1934	12¼	Ibadan, Benin, Onitsha and Umuahia
Total . .	59 [1]	

[1] *Includes a 20-acre plantation block established with self-fertilised seedlings.*

It was stated in the report for the period January–June 1934 (this BULLETIN, 1934, **32**, 454) that the 1930 areas at Benin and Umuahia began to fruit during 1933 when the average age of the palms was four years. It is assumed that all seedlings are one year old when planted out in the field, and the age of these palm plots is calculated on that basis. In calculating yields per acre, 57 palms are taken as being equivalent to one acre, spacing 29 ft. triangular. Yields for 1934, the fifth year, are appended, and again the yields of all types are grouped, while fruit weights have been ignored.

—	Number of bunches.		Weight of bunches in lb.		Average weight per bunch in lb.
	per acre.	*per bearing palm.*	*per acre.*	*per bearing palm.*	
Benin . .	563	13·3	1,424	33·5	2·5
Umuahia .	465	11·6	1,683	42·2	3·6

The percentages of palms bearing in 1933 (fourth year) and in 1934 (fifth year), were as follows :

	1933.	1934.
Benin . . .	26 per cent.	74 per cent.
Umuahia . .	23 ,, ,,	70 ,, ,,

Mr. W. A. Watson, Agricultural Chemist, reports that the question of determining moisture and dirt content of palm oil is being studied. Palm oil of high free fatty acid content—so called " Hard " and " Sleepy " oil—appears to lose moisture more or less continuously when heated in an

oven at 105° C. This continued loss of weight is also observed when dirt or sludge is present in the oil in any quantity, irrespective of whether the oil is hard or soft. Filtering the oil results in a constant weight being speedily reached in the subsequent heating of soft oils. The bulk of the moisture appears to be held by the sludge. With "hard" oils, filtering hastened the arrival at a point where further heating gave only the slight continuous loss of weight characteristic of hard oils and probably due to volatile free fatty acids.

When known amounts of water were added to filtered oils and well shaken, heating at 105° C. rapidly drove off the added water. A method involving the passing of dry carbon dioxide over heated oil and collecting the moisture in a calcium chloride tube gave only a partial moisture recovery.

Fibres

Cotton

Nigeria.—Mr. J. K. Mayo, Agricultural Botanist, Northern Provinces, has furnished the following report on work carried out during the period July–December 1934.

With reference to the report for January–June 1934 (this Bulletin, 1934, **32**, 459), the spinning test report of the two new Allen strains has been received from the Shirley Institute and confirms the brokers' report as regards the inferiority of D-31 to ordinary Allen, but does not show that C-31 is very much better than Allen, though its "staple" was longer. However, these two strains together with E-31 (which was not sent to England for report) have certain agricultural merits. To begin with they are highly resistant to jassid, particularly C-31 and E-31, and two of them, D-31 and E-31, are highly resistant to leaf curl, as the following figures show:

Bomo Yield Trial

16 plots of ordinary Allen

5 plots of each variety

Variety.	Per plot.	Average No. of plants damaged by leaf curl.	Per cent. leaf curl.
Allen . . .	937	133	14·2
K1 . . .	953	95	10·0
L . . .	858	167	19·5
D-31 . . .	927	17	1·8

Samaru Small-scale Yield Trial
9 plots of each variety

Variety.	Total No. of plants.	Total No. of plants damaged by leaf curl.	Per cent. leaf curl.
Allen	776	113	14·6
K1	779	98	12·6
L	775	205	26·4
S.G.27	779	146	18·7
C-31	775	109	14·1
D-31	776	45	5·8
E-31	772	16	2·1

None of the sixteen plants of E-31 were seriously damaged by the disease and this strain may be considered to be almost immune. Strain L is obviously more susceptible than Allen, and so is S.G.27 (introduced from Uganda), but the significance has yet to be worked out. As might be expected, these two strains produce lint of higher quality than the others. Strain L is potentially a high-yielding strain which is reduced to the level of Allen, or lower, by its susceptibility to leaf curl and jassids.

MINERAL RESOURCES

CYPRUS

The Imperial Institute has received from the Acting Inspector of Mines and Labour the following report on mining activities in Cyprus during the last six months of 1934.

Continued low prices and a restricted demand in the European markets have adversely affected the sales of copper and sulphur. The Cyprus Mines Corporation has completed the construction of the new metallurgical plant and is now in a position to ship high-grade concentrates. The Corporation has also actively worked the gold-bearing lode at Skouriotissa with encouraging results, and the Asbestos Company, in spite of keen competition, has increased its sales of low-grade fibre. The amount of labour employed on both mines is well maintained.

There has been an increase in the number of Prospecting Permits issued, but no outstanding discoveries are recorded.

Work done by the Cyprus Mines Corporation at the Skouriotissa Pyrites Mine

	Last 6 months 1934.	Last 6 months 1933.
Underground development, footage .	418	2,463
Tonnage mined	30,853	91,379
Underground labour (average per day) .	585	562
Tonnage exported	43,811	90,680
Labour, surface and underground (average per day)	1,136	734

Work carried out at the Mavrovouni Pyrites Mine of the Cyprus Mines Corporation

	Last 6 months 1934.	Last 6 months 1933.
Underground development, footage	8,375	3,530
Tonnage mined	66,703	11,370
Underground labour (average per day)	460	100
Tonnage exported	14,381	7,301
Labour, surface and underground (average per day)	1,234	339

Work done at the Lymni Mine of the Cyprus Sulphur and Copper Co. Ltd.

	Last 6 months 1934.	Last 6 months 1933.
Underground development, footage	nil	nil
Opencast, overburden removed, cubic yds.	nil	nil
Tonnage mined	nil	nil
Copper precipitate produced, tons	nil	7½
Labour (average per day)	2	3

Work done at the Troodos Mines of the Cyprus Chrome Co. Ltd. (Mining Lease and Prospecting Permit areas)

	Last 6 months 1934.	Last 6 months 1933.
Development, total footage	1,445	1,063
Tonnage mined	846	nil
Tonnage exported	nil	nil
Labour (average per day)	48	52

Work done by the Cyprus Mines Corporation, Skouriotissa, in the production of "Devil's Mud" (auriferous andesite)

	Last 6 months 1934.	Last 6 months 1933.
Underground development, footage	12,293	8,580
Tonnage mined	4,342	2,342
Gold content of gold ore exported, oz.	10,488	nil
Silver content of gold ore exported, oz.	70,143	nil
Gold content of gold-bearing metallic precipitate exported, oz.	2,604	nil
Silver content of the above metallic precipitate, oz.	20,194	nil

Work done by the Cyprus and General Asbestos Co. Ltd., Amiandos (formerly Cyprus Asbestos Co. Ltd.)

	Last 6 months 1934.	Last 6 months 1933.
Rock mined, tons	303,851	238,002
Rock treated, tons	68,546	52,958
Finished asbestos produced, tons	4,338	2,277
Finished asbestos exported, tons	4,000	3,388
Average daily labour (quarries only)	580	625
Average daily labour (all operations)	1,036	1,080

Work done by the Hellenic Co. of Chemical Products and Manures Ltd. (Lease on Troodos)

	Last 6 months 1934.	Last 6 months 1933.
Rock mined, tons	nil	nil
Rock treated, tons	nil	nil
Finished asbestos produced, tons	nil	nil
Finished asbestos exported, tons	nil	nil
Average daily labour (quarries only)	nil	20
Average daily labour (all operations)	1	46

Minerals exported other than those dealt with above were as follows:

	Last 6 months 1934.	Last 6 months 1933.
Gypsum, calcined, tons	3,107	5,015
Gypsum, raw, tons	100	1,085
Stone, building, cubic yds. . . .	34	2
Stone, pumice, tons	965	99
Terra umbra, tons	2,048	2,540
Terra verte, tons	nil	7

GOLD COAST

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended December 31, 1934.

During the greater part of the period under review only two geologists were in the field; the Director and the other geologist were on leave until September and attended a course in Applied Geophysics at the Imperial College of Science, London, during October to December 1934.

Field work included the examination of numerous gold mines and prospects in the Axim, Tarkwa and Bekwai Districts; the examination of the country west of the railway line between Insu and Dunkwa and around Bompata; a hydrographic survey of Lake Bosumtwi and a detailed study, made at the request of Bibiani Limited, of the surface and underground workings of the Bibiani mine.

Gold.—Interest in gold continues unabated. Concessions and options have been taken up on a liberal scale and intensive prospecting is being carried out in many districts. Two new mines came into production in 1934 and it is expected that at least two more will commence to produce gold in 1935.

Diamonds were found in many streams in the belt of country 8 miles north-east and 8 miles south-west of the Prahsu-Brofo Yedry motor-road near Amodroasi (Obuasi District). These occurrences are situated on the same line and in similar geological position, i.e. close to the Birrimian–Tarkwaian contact, as those around the Ofin-Pra confluence and near Ntranang and Afoso.

Andalusite.—This mineral occurs in large quantities in the soil and overburden in an area close to the old village of Abodum 4 miles east of Bekwai, Ashanti. Some of the earth contains up to 50 per cent. or more of andalusite. Samples were submitted to the Imperial Institute for testing. They report that an andalusite concentrate can readily be obtained by washing, crushing and screening the andalusite earth, but owing to the complex mineral

nature of the andalusite crystals it does not appear likely that they can be sufficiently freed from alkalis and ferruginous matter to constitute a satisfactory raw material for the manufacture of mullite refractories.

Mineral Production.—The following table shows the mineral production for 1934 and the corresponding figures for the previous year :

	1933.	1934.
Gold (fine ounces)	305,908	326,040
Diamonds (carats exported)	1,142,268 [1]	1,446,540 [2]
Manganese Ore (wet tons exported)	318,492 [1]	365,178

[1] *April* 1933–*March* 1934. [2] *Estimated.*

The Gold Coast in 1934 was the second largest producer of diamonds in the world.

Two new geological maps of the southern section of the Gold Coast, one showing the geology only and the other the positions of the gold mines and prospects as well as the geology, have recently been published. The scale of the maps is 1 : 500,000.

Memoir No. 4 on Gold in the Gold Coast is now in the press.

NIGERIA

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended December 31, 1934.

Gold.—The effect of the continued high price of gold is reflected in the output, which is increasing slowly and steadily and for the year 1934 has reached 37,024 oz. ; a record for Nigeria. Most of the gold is being won from alluvial deposits, but some attention is being focused on reefs with promising results.

Columbite.—Since the early days of tin-mining it has been known that columbite existed in Nigeria in some quantity, but until recently there has been little or no demand for it. Lately, however, a considerable amount of interest has been displayed in this mineral and contracts have been made for the supply of amounts which a short time ago would have been considered big parcels of this ore.

Diamonds.—The occurrence of diamonds mentioned in the last half-yearly report (this BULLETIN, 1934, **32,** 470) has occasioned a good deal of interest, and prospecting parties are now investigating certain areas to ascertain if the stones occur in economic quantities.

Water.—Geological investigations for water supply and shaft sinking have been continued in the Northern Provinces, with the result that for the half year under review,

eighty-five wells have been brought into production. This brings the total number of producing wells completed during 1934 to 189 for a footage of 22,119 ft.

In the south-west of Sokoto Province, the programme has for the present been completed and work has been transferred to the north-west of the Emirate. This area, which is sparsely populated, suffers in the dry season from a severe shortage, which has naturally retarded its development. It lies along the International Boundary and southwards joins up with Argungu Division and includes an area of roughly 2,000 square miles. The number of shafts completed in this Emirate during the year is forty-five.

Work has been continued successfully in the Emirates of Katsina and Daura, which are now grouped together under the new Katsina Province. At the request of various district heads, the original programme has been extended and continued in the north-east of the Katsina Emirate, and when this is completed work will be transferred to other parts of the Emirate which are also badly in need of water. In this area, as part of a scheme of afforestation being carried out by the Forestry Department, plant nurseries have been established for which this Department has provided the necessary water supply.

In Kano Province, work is in progress in the Emirates of Gumel and Kano. In the latter Emirate particular attention is being paid to the more arid northern districts. Geological investigations led to the prediction that pressure water would be found to underlie this area, and this has been borne out by subsequent sinkings. The popularity and practical value of this work are evidenced in Gumel by the large influx of settlers and cattle that has taken place since it was commenced.

In Bornu Province, the line of wells along the Balle–Magumeri road and in the country adjacent to it has been completed and is being carried southwards towards Maiduguri. Deep wells and pressure water are the features of this area. Many shafts have been constructed over 200 ft. in depth and some of over 300 ft. Several pressure rises of 60 ft. have been recorded and lately one of 113 ft. has been obtained.

A start has been made in the development of shallow water supplies by means of drive tube wells. This forms a rapid and comparatively cheap method of obtaining supplies of good water where the conditions are found to be suitable. Installations have already been completed at Kazaure and Gusau and have proved very popular, and further installations are being considered for other towns and villages.

UGANDA

The Imperial Institute has received the following statement from the Director regarding the work carried out by the Geological Survey during the six months ended December 31, 1934.

Owing to leave arrangements the work of the Survey, during this period, has been somewhat restricted. Very considerable public interest has been taken in prospecting, and numerous samples have been received in the laboratory for testing, identification or assay; while the number of enquiries in person and by letter has been steadily increasing. With a staff augmented by the appointment of two field geologists it is hoped that in 1935 further mineral development will follow in the wake of geological exploration.

Gold.—During the year 1934 a very decided increase in the quantity of gold exported occurred, the value being somewhat over £40,000. The figures for previous years were: 1931, £401; 1932, £3,274; 1933, £7,360. Most of this is from alluvial deposits and it is clear that one of the next steps in proper development is the location of the reefs yielding the gold, though there still remain many areas (including most of the Kingdom of Buganda) which have not yet been closely prospected for alluvial deposits. When it is stated that the Muti stream, in a steep-sided ravine hardly more than 1,400 ft. long,[1] yielded 4,000 oz. of gold, and that many such valleys in bush-covered country still await prospection, it will be realised that much work remains to be done.

Towards the end of the year an area in Igara, western Ankole, which had been closed owing to the discovery by an officer of the Geological Survey Department of promising amounts of alluvial gold,[2] was given out under an exclusive prospecting licence.

In the Eastern Province the westerly continuation from Kenya of the Kakamega goldfield into Uganda occurs, and development so far has proceeded but slowly. Dr. Davies has been able to continue his investigations in this area and the mode of occurrence of the gold there has now been determined. A little farther west in Busoga traces of gold were found by the Survey and a rapid geological reconnaissance confirmed the presence of Karagwe-Ankolean shales and quartzites which towards the north are intruded by granites. Although the rocks are generally thickly covered with red soil, and lateritic ironstone and

[1] *Ann. Rept. Geol. Surv., Uganda,* 1933, p. 34.
[2] This BULLETIN, 1934, **32**, 151.

vegetation is dense, it is an area which deserves proper prospecting.

Cassiterite.—Development still continues at Mwirasando mine and the output of tin ore has been maintained at about 30 tons a month. Numerous other occurrences of cassiterite in Ankole and Kigezi are being investigated, but no new startling discovery was made during this period.

Copper.—At Kilembe copper mine, near the Ruwenzori range, the operating company has, by means of geophysical surveys combined with active prospecting along the line of mineralisation, proved further tonnages of ore.

Tantalite.—Further interest has been shown in tantalite, and now several deposits are known in south-western Uganda, where this mineral occurs sometimes with cassiterite and sometimes alone, and if a market can be found for the ore some of these occurrences may be further opened up.

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The World Cotton Position. By J. A. Todd. *Trop. Agric., W.I.* (1935, **12**, 16–19).

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Technological Reports on Standard Indian Cottons, 1934. By Nazir Ahmad. *Tech. Bull. No. 26, Series A, Indian Central Cotton Committee Tech. Lab.* Pp. 86, 13½ × 8½. (Bombay: Indian Central Cotton Committee, 1934.) Price Re. 1–8.

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Russia's Pulp Wood Resources. Their Extent, Methods of Exploitation and Relation to the Paper Industry. *Pulp and Paper, Canada* (1934, **35**, 622–628, 658).

Rubber

Review of the More Important Publications on Rubber Cultivation issued in 1933. By C. J. J. van Hall. *Intern. Rev. Agric.* (1934, **25**, 242T–250T; 295T–306T).

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Handbook of the Rubber Exhibition, Science Museum, South Kensington, London, November 1934 to April 1935. Pp. 44, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 6*d.* Includes a brief account of the history of rubber from its source to the finished product and a descriptive catalogue of the exhibits.

Rubber and Agriculture. Pp. 64, 8¼ × 5½. (London: Rubber Growers' Association, 1934.) Deals with the use of rubber in agricultural machinery, buildings, etc.

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The Importance of Tobacco Mosaic. By L. F. Mandelson. *Queensland Agric. Journ.* (1934, **42**, 538–545). An account of the disease, its effect, and control.

Stem Rot of Tobacco caused by *Sclerotinia sclerotinia* (Lib.) de Bary. By K. F. Kheswalla. *Ind. Journ. Agric. Sci.* (1934, **4**, 663–673).

Een Nieuwe Bibitziekte in de Besoeki Tabak. By J. C. s'Jacob. *Med. No.* 50, *v.h. Besoekisch Proefsta.* (*Rubber, Koffie en Tabak*), pages 53–61. An account of a new disease of tobacco seedlings caused by the fungus *Pythium aphanidermatum.*

Annual Report on the Activities of the Government Tobacco Warehouse and the Progress of Tobacco Manufacture in Mauritius for the year 1933. Pp. 22, 9¾ × 6¼. (Port Louis: Government Printer, 1934.)

Common Mistakes in Bright Tobacco Production. By N. A. R. Pollock. *Queensland Agric. Journ.* (1934, **42**, 379–385).

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Intensivierung der Chinakultur in Mittelamerika. By E. Deger. *Tropenpflanzer* (1935, **38**, 24–28). Deals with cinchona cultivation in Central America.

Miscellaneous Agricultural Products

Matières à Mastiquer. By C. Crevost. *Bull. Écon., Indochine* (1934, **37**, 722–729). Brief notes on vegetable products used for chewing purposes, such as gambir, areca nuts, and various roots and barks.

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Report of the Veterinary Director-General, Department of Agriculture, Canada, for the year ending March 31, 1934. Pp. 59, 9¾ × 6. (Ottawa: King's Printer, 1934.)

Annual Report of Veterinary Department, Nigeria, for the year 1933. Pp. 15, 13¼ × 8½. (Lagos: C.M.S. Bookshop, 1934.) Price 1*s.* 6*d.*

Annual Report of the Department of Veterinary Science and Animal Husbandry, Tanganyika, 1933. Pp. 111, 13 × 8. (Dar es Salaam: Government Printer, 1934.) Price 4*s.*

Report of the Chief of the Bureau of Animal Industry, United States Department of Agriculture, for the year ending June 30, 1934. Pp. 52, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 5 cents.

Organisation et Exploitation des Elevages au Congo Belge. I. Bêtes Bovines. By E. Leplae. Pp. 499, 9½ × 6½. (Bruxelles: Direction Générale de l'Agriculture du Ministère des Colonies, 1933.) Price 35 francs.

Beef Cattle Feeding Experiments. By H. Hackedorn and R. McCall. *Bull. No.* 302, *Washington Agric. Exper. Sta.* Pp. 16, 9 × 6. (Pullman: State College, 1934.)

Parasites of Cattle. By F. H. S. Roberts. *Queensland Agric. Journ.* (1934, **42**, 674–689).

A Study of the Ticks in Kenya Colony. The Influence of Natural Conditions and other Factors on their Distribution and the Incidence of Tick-borne Diseases. Part III. Investigation into the Tick Problem in the Masai Reserve. By E. A. Lewis. *Bull. No.* 7 *of* 1934, *Dept. Agric., Kenya.* Pp. 67, 9¾ × 6. (Nairobi: Government Printer, 1934.)

Ticks, Tick-borne Diseases and their Eradication in South Africa. By G. A. H. Bedford and H. Graf. *Farming in S. Africa* (1934, **9**, 431–434).

The Handling of Meat in Small Refrigerators. By R. B. Haines and E. C. Smith. *Food Investigation Leaflet No.* 4, *Dept. Sci. and Indust. Res.* Pp. 5, 9¾ × 6. (London: Department of Scientific and Industrial Research, 1934.)

Annual Report, National Institute for Research in Dairying, 1933. Pp. 85, 9¼ × 7. (University of Reading, 1934.)

An Economic Study of Dairy Farming in Kenya. By V. Liversage. *Bull. No.* 6 *of* 1934, *Dept. Agric., Kenya.* Pp. 30, 9¾ × 6¼. (Nairobi: Government Printer, 1934.)

Report of the Chief of the Bureau of Dairy Industry, United States Department of Agriculture, for the year ended June 30, 1934. Pp. 24, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 5 cents.

The Vitamin A Requirements of Dairy Cows. By G. S. Fraps, O. C. Copeland and R. Treichler. *Bull. No.* 495, *Texas Agric. Exper. Sta.* Pp. 21, 9 × 6. (Brazos County: Agricultural College, 1934.)

Chemical Control in the Manufacture of Condensed Milk. By W. L. Davies. *Food* (1934, **3**, 290–292; 335–338).

Studies on the Phosphorus Requirements of Sheep. II. The Effect of Supplying Phosphatic Supplements to Growing Lambs De-

pastured on Phosphorus-Deficient Country. By H. R. Marston, E. W. Lines, T. J. Marshall and J. S. Hosking. *Counc. Bull. No.* 85, *Sci. and Indust. Res., Australia.* Pp. 22, 9½ × 6. (Melbourne: Council for Scientific and Industrial Research, 1934.)

The Parasites of Sheep. By F. H. S. Roberts. *Queensland Agric. Journ.* (1934, **42**, 337–359).

Sheep Dips. By J. Stewart Remington. *Manufacturing Chem.* (1934, **5**, 364–369). Gives formulæ for various dips.

The Lamb for Export. Experiments at the Avondale Experiment Farm. By G. L. Sutton, J. Thomas and N. Davenport. *Journ. Dept. Agric., W. Australia* (1934, **11**, 355–371).

Pig Feeding. By L. A. Downey. *Queensland Agric. Journ.* (1934, **41**, 504–512; 619–633).

The Calcium, Phosphorus and Vitamin D Requirements of Swine. By G. Dunlop. *Journ. Agric. Sci.* (1935, **25**, 22–49).

Bacon Curing. The Dry-Salt and Tank Curing of Wiltshire Sides. By E. H. Callow. *Leaflet No.* 5, *Food Investigation, Dept. Sci. Indust. Res.* Pp. 8, 9½ × 6. (London: Department of Scientific and Industrial Research, 1934.)

Rabbit Production. By F. G. Ashbrook and C. E. Kellogg. *Farmers' Bull. No.* 1730, *U.S. Dept. Agric.* Pp. 38, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 5 cents. Includes the preparation of meat and skins for the market, and the home-tanning of skins.

Il Peccari e le sue Imitazioni. By B. Avenati-Bassi. *Boll. Staz. Sper. Pelli Mat. Conc.* (1934, **12**, 395–397). Deals with peccary, capybara and similar skins, used for glove leather.

Eggs and Poultry. Report of Reorganisation Commission for England and Wales. *Bull. No.* 42, *Econ. Series, Min. Agric. and Fisheries.* Pp. 211, 9¾ × 6. (London: H.M. Stationery Office, 1935.) Price 1*s.*

The Manufacture of Egg Products. By V. Liversage. *Bull. No.* 4 *of* 1934, *Dept. Agric., Kenya.* Pp. 9, 9¾ × 6. (Nairobi: Government Printer, 1934.)

Utilization of Poultry Feathers. By H. Hodges. *Journ. Min. Agric.* (1934, **41**, 750–754).

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Beekeeping for Beginners. By J. W. Thomlinson. *Journ. Dept. Agric., Victoria* (1934, **32**, 71–75; 283–286; 398–402).

Annual Report on the Fisheries of New South Wales for the year 1933. Pp. 12, 13¼ × 8¼. (Sydney: Government Printer, 1934.)

Report of the Commissioner of Fisheries, United States Department of Commerce, for 1933, with Appendices. Pp. 483, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.)

Sardine Canning in California. By R. S. Croker. *Food Manufacture* (1934, **9**, 421–424; 1935, **10**, 7–10).

Forestry

General

Report on Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for the year 1933–34. Pp. 27, 13¼ × 8¼. (Melbourne: Division of Forest Products, 1934.) Mimeographed copy.

Programme of Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for 1934–35. Pp. 31, 10 × 8. Mimeographed copy.

Forestry in New South Wales. A Report on the Indigenous Forests, Plantations and Forest Industries of New South Wales, with Recommendations for Future Administration and Practice. By S. L. Kessell. Pp. 70, 13¼ × 8½. (Sydney: Government Printer, 1934.) Price 4*s.* 6*d.*

Report of the Forestry Commission, New South Wales, for the year ended December 31, 1933. Pp. 11, 13¼ × 8½. (Sydney: Government Printer, 1934.) Price 1*s.* 1*d.*

Report on the Operations of the Forests Department, Western Australia, for the year ended June 30, 1934. Pp. 29, 13 × 8¼. (Perth: Government Printer, 1934.)

Les Fôrets de la Guadeloupe. By R. Grébert. *Bull de l'Agen. Écon. des Col.* (1934, **27**, 639–702; 765–875; 941–1015).

Forest Research in India, 1933–34. Part I. The Forest Research Institute. Pp. 92, 9¾ × 6¼. (Delhi: Manager of Publications, 1934.) Prices Rs. 1–12 or 3*s.*

Quinquennial Review of Forest Administration in the Province of Assam, for the period 1929–30 to 1933–34, with the Progress Report of Forest Administration for 1933–34. Pp. 69, 13¼ × 8¼. (Shillong: Government Press, 1934.) Price Rs. 4–8 or 6*s.* 9*d.*

Annual Report on Working Plans, Silviculture and Entomology in Burma for the year 1933–34. Pp. 57, 9¾ × 7½. (Rangoon: Superintendent, Government Printing, 1934.) Price Rs. 2 or 3*s.*

Report on Forest Administration in the Utilization Circle, Burma, for the year ended March 31, 1934. Pp. 81, 9¾ × 6¼. (Rangoon: Government Printing and Stationery, 1934.) Price Rs. 3 or 4*s.* 6*d.*

Annual Report of the Forest Department, Kenya, 1933. Pp. 36, 9¾ × 6. (Nairobi: Government Printer, 1934.) Price 1*s.*

Forest Research in Malaya. By J. G. Watson. *Empire Forestry Journ.* (1934, **13**, 223–231).

Report on the Forest Administration of Nigeria for the year 1933. Pp. 25, 13¼ × 8½. (Lagos: C.M.S. Bookshop, 1934.) Price 2*s.*

Treatment and Care of Tree Wounds. By J. F. Collins. *Farmers' Bull. No.* 1726, *U.S. Dept. Agric.* Pp. 38, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1934.) Price 5 cents.

A Key to the Eucalypts. By W. F. Blakely. Pp. 339, 9½ × 6. (Hornsby, N.S. Wales: W. F. Blakely, 1935.) Price 10*s.* Intended as a companion to J. H. Maiden's *Critical Revision of the Genus Eucalyptus.* Includes descriptions of 500 species and 138 varieties.

The Cultivation of Mexican Pines in the Union of South Africa, with Notes on the Species and their Original Habitat. By C. C. Robertson. *Empire Forestry Journ.* (1933, **11**, 58–72; 250–269; **12**, 71–90; 241–253; 1934, **13**, 69–76; 248–258).

Timbers

Report of the Committee of the Department of Scientific and Industrial Research, on the Mechanical Testing of Timber. Pp. 41, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 1*s.*

Some Terms used in the Mechanical Testing of Timber. *Trade Circ. No.* 26, *Div. Forest Prod., Counc. Sci. and Indust. Res., Australia.* Pp. 14, 9½ × 6. (Melbourne: Council for Scientific and Industrial Research, 1934.)

Het Kunstmatig Drogen van Hout. By A. T. J. Bianchi. *Tectona* (1934, **27**, 834–906). With short summary in English. Deals with the kiln-drying of timber.

Brittle Heart in Australian Timbers: A Preliminary Study. By H. E. Dadswell and I. Langlands. *Journ. Counc. Sci. and Indust. Res., Australia* (1934, **7**, 190–196).

The Chemistry of Australian Timbers. Part IV. A Study of the Lignin Determination, II. By W. E. Cohen. *Pamphlet No.* 51, *Counc. Sci. Indust. Res., Australia.* Pp. 20, 9½ × 6. (Melbourne: Council for Scientific and Industrial Research, 1934.)

The Control and Prevention of Borer Attack in Buildings, etc. By A. R. Entrican. *Leaflet No.* 23, *New Zealand State Forest Service.* Pp. 15, 9 × 6. (Wellington: Government Printer, 1934.)

Wood Borers in Australia. Part III. Pin-hole Borers. *Trade Circ. No.* 25, *Counc. Sci. Indust. Res., Australia.* Pp. 11, 9½ × 6. (Melbourne: Government Printer, 1934.)

Queensland Pine Beetle. By A. R. Brimblecombe. *Queensland Agric. Journ.* (1934, **42**, 546–560). Account of this borer of seasoned pine and its control.

Testing of Indian Timbers for Veneer and Plywood. Interim Report on Work under Project VIII, Forest Research Institute, Dehra Dun. By W. Nagle. *Indian Forest. Rec., Econ. Series* (1934, **20**, Part XIV, 1–56).

Sur l'Origine des Ebènes Commerciaux de l'Antiquité du XVII–XVIII Siècle et de l'Époque Contemporaine. By A. Chevalier. *Rev. Bot Appl. et d'Agric. Trop.* (1934, **14**, No. 159, 948–965). Discusses the botanical origin of ebonies in use from ancient times to the present.

Notes on Malayan Timbers. Chengal (*Balanocarpus Heimii* King) and Resak (*Shorea* spp.). By H. E. Desch. *Malayan Forester* (1934, **3**, 191–202).

The Properties of Mninga, *Pterocarpus angolensis*, from Tanganyika Territory. Project 22, Investigation 19, *For. Prod. Res. Lab., Dept. Sci. and Indust. Res.* Pp. 14, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1934.)

The Properties and Uses of Matai (*Podocarpus spicatus*). By A. R. Entrican. *Leaflet No.* 21, *New Zealand State Forest Service.* Pp. 9, 9 × 6. (Wellington: Government Printer, 1934.)

The Properties and Uses of Miro (*Podocarpus ferrugineus*). By A. R. Entrican. *Leaflet No.* 20, *New Zealand State Forest Service.* Pp. 7, 9 × 6. (Wellington: Government Printer, 1934.)

The Properties and Uses of Totara (*Podocarpus Totara* and *P. Hallii*). By A. R. Entrican. *Leaflet No.* 22, *New Zealand State Forest Service.* Pp. 9, 9 × 6. (Wellington: Government Printer, 1934.)

Gums and Resins

Further Notes on the use of *Schleichera trijuga* (Kusum) in Lac Cultivation. By D. Norris. *Bull. No.* 20, *Ind. Lac Res. Inst.* Pp. 4, 9¾ × 7½. (Namkum, Ranchi, Bihar and Orissa: Indian Lac Research Institute, 1934.) Price As. 8.

A Check List of the Chalcidoidea bred at Namkum from the Lac Insect (*Laccifer lacca*), with some Notes as regards their Function, Economic Importance and Control. By D. M. Glover. *Bull. No.* 21, *Indian Lac Res. Inst.* Pp. 14, 9½ × 7½. (Namkum, Ranchi, Bihar and Orissa: Indian Lac Research Institute, 1934.) Price Re. 1.

Sex-ratio Variability and the Problems of Reproduction among Lac Insects. By S. Mahdihassan. Pp. 10, 10½ × 7. Reprint from the *Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam*, 1933, xxxvi, No. 3.

Specificity of Parasticism by *Eublemma amabilis*. By S. Mahdihassan. Pp. 2, 9¾ × 7½. Reprint from *Current Science*, 1934, **3**, No. 6.

Reseignments sur l'Arbre à Laque du Tonkin. By R. du Pasquier. *Bull. Econ., Indochine* (1934, **37**, 494–501). Deals with the cultivation of the tree *Rhus succedanea* Linn., which yields a lacquer.

Tanning Materials

Manufacture of Tannin Extract from Avaram Bark (*Cassia auriculata* Linn.). By Keshaviah Aswath Narain Rao and Shaha L. Janniah. *Journ. Ind. Inst. Sci.* (1934, **17A**, Pt. VIII, 95–104).

Estimation of Tannin in Plant materials. Part I. *Cassia auriculata*. By N. Srinivasan. *Journ. Ind. Inst. Sci.* (1934, **17A**, Part XV, 165–173).

L'Entandrophragma palustris Staner. By L. Tihon. *Bull. Agric., Congo Belge* (1934, **25**, 21–25). A study of the bark for its tannin and alkaloid content.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

The Pocket Guide to the West Indies. By Sir Algernon Aspinall, C.M.G., C.B.E. Pp. xl + 527, $6\frac{1}{2} \times 4$. New and Revised Edition, 1935. (London: Sifton, Praed & Co., Ltd., 1935.) Price 10*s*.

The publication of the eighth edition of this well-known guide book bears witness to the increasing appreciation of the West Indies as a tourist resort and of the success of the efforts of the author to provide a thoroughly reliable account of this attractive and interesting region of the world. Although primarily written for the tourist the book is no less indispensable to the resident in the West Indies or to all those in other countries who have need of knowledge of the West Indian islands and the adjacent mainland.

The scope of the book has steadily grown, and whilst the British colonies from Bermuda to British Honduras and British Guiana are dealt with in most detail, adequate accounts are given of the island possessions of France, Holland and the United States, and also of Cuba, Porto Rico, Haiti and San Domingo, Surinam, Venezuela and the Panama Canal.

The information given about each island or territory usually includes an account of its general physical and climatic features, history, constitution, industries, communications, hotels, sports and sights. The last section covers not a mere list of places worth seeing by the visitor, but an attractive, and often very full, account of the chief places of interest, whether due to present scenic, industrial or other reasons, or to their importance in bygone days. Very valuable features of the book are some eighteen maps,

eleven plans of the chief towns, etc., and twenty-three full-page illustrations either of present scenes or of the more stirring past, such as the Glorious Battle of the Saints, and Nelson's quarters at Port Royal, Jamaica. Modern progress is indicated by the addition in Appendix II of particulars of the Air Transport Services operating in the West Indies.

EASTERN AFRICA TO-DAY AND TO-MORROW. Compiled and Edited by F. S. Joelson. Pp. xvii + 376, 10 × 6½. (London: "East Africa," 1934.) Price 7*s*. 6*d*.

Mr. Joelson, the founder and editor of *East Africa*, has produced this volume to mark the completion of the first ten years' existence of his weekly journal. In a Foreword he explains that its compilation is the result of an endeavour to "enlist the co-operation of those best qualified to discuss the various topics which demanded inclusion," with the result that it is a work setting "a new standard in Eastern African literature," if not in African literature generally. The contents consist of a series of articles on the East African countries by forty-five different authors, many of whom occupy high positions in Government service or elsewhere. The territory covered ranges from the Sudan and Somaliland in the north to Southern Rhodesia and Portuguese East Africa in the south, and a perusal of the volume, which is illustrated with maps and photographs, will furnish the reader with much valuable and interesting information regarding this vast region and its problems.

GOVERNOR ARTHUR'S CONVICT SYSTEM: VAN DIEMEN'S LAND, 1824–36. A Study in Colonisation. By William Douglass Forsyth, B.A. Royal Empire Society Imperial Studies, No. 10. Pp. xv + 213, 8¾ × 5¾. (London; New York; Toronto: Longmans, Green & Co. Ltd., 1935.) Price 7*s*. 6*d*.

This treatise, like others issued in the same series, is of an academic rather than a practical nature, but it deals with a subject of somewhat special interest since, as the author mentions in his Introduction, "The development of New South Wales and Tasmania depended on the assigned service of convicts who had lost their liberty by due sentence of law, and therefore in a sense it is true to say that they were colonised by slavery."

The outstanding features of the situation, with due recognition of the agreeable as well as the unpleasant aspects of the prevailing conditions, are clearly described in the book, which is well arranged and readable, and can

be recommended both to students of Empire history and to readers interested in the development of British criminal law. Mr. Forsyth has documented his treatise with copious references to literature (including Government papers of various kinds) in addition to a special chapter on the bibliography of the subject.

Economics with Applications to Agriculture. By Edwin F. Dummeier, Ph.D., and Richard B. Heflebower, Ph.D. Pp. x + 742, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1934.) Price 22*s.* 6*d.*

The authors of this volume, who are respectively Professor and Associate Professor of Economics at the State College of Washington, have written it primarily as a text-book for students, but they express the hope that it may have a favourable reception from other persons "who are interested in the problem of agricultural well-being." Whilst the subject is treated largely from an American standpoint, many of the sections are of general application, and the wide scope of the work may be indicated by the following titles of some of its thirty chapters: Economic Problems of Agriculture; The European Background of Economic Life; Some Principles of Trade and Production; Farm Organisation; Monopoly and Agriculture; Capital and Interest; Land Returns and Land Values; Price-level Movements and Agriculture; International Trade and Agriculture; Taxation and the Farmer; Marketing and Co-operation; Business Cycles and Depressions; Rural and Urban Prosperity.

The book forms a clearly written, detailed, and most informative and suggestive treatise, which should find many appreciative readers among those interested (whether academically or practically) in modern economic problems and their special relation to agriculture.

Gardening in East Africa: A Practical Handbook. By Members of the Kenya Horticultural Society and of the Kenya and Uganda Civil Services. Edited by A. J. Jex-Blake, M.D., F.R.C.P. Pp. xv + 330, 8½ × 5½. (London, New York and Toronto: Longmans, Green & Co., 1934.) Price 12*s.* 6*d.*

This book deals with gardening in British East Africa, i.e. Kenya, Uganda and Tanganyika Territory. Owing to the great range in altitude and consequent diversity in climatic conditions met with in this region, a wonderful variety of plants can be grown with success. Kenya, with its large number of white settlers with permanent home-

steads, has naturally led the way as indicated by the existence for some twelve years of an Horticultural Society. A happy co-operative effort by twelve members of this Society and six scientific officials—Meteorologist, Chemist, Botanist, Mycologist, Entomologist and Forester, under the able leadership of Dr. Jex-Blake, has had a valuable result. Each chapter is written by someone possessed of scientific knowledge, or the wisdom gained by practical experience, of his or her subject.

The more general sections include climatology, the soil and plant growth, manuring and tilling, elementary horticulture, plant propagation, insect pests and diseases of the garden. The other chapters are devoted mostly to such groups of plants as annuals, perennials, roses, climbers, flowering trees and shrubs, bulbs, indigenous plants, lawns, vegetables, fruits, with also accounts of gardening at the coast, and in Uganda.

The treatment in each of the chapters on the above-mentioned groups is to give a list of plants of proved merit with short practical notes on their nature, cultural treatment, and frequently of the conditions to which they are suited.

Six coloured plates add to the attractiveness of a book which will undoubtedly be of great practical value to all garden lovers in East Africa, and also of much interest to those with similar interests in other tropical countries.

THE GENETICS OF GARDEN PLANTS. By M. B. Crane and W. J. C. Lawrence. Pp. xvi + 236, 9 × 6. (London: Macmillan & Co., Ltd., 1934.) Price 10*s.* 6*d.*

The authors of this valuable book, in carrying out their investigations at the John Innes Horticultural Institution, have had exceptional experience in the scientific and practical aspects of plant genetics and are qualified in an eminent degree to prepare a work which is designed to afford an introduction to the essential principles of modern cytology and genetics and to give an account of the results of recent researches in these fields in their bearing upon orchard and garden plants. It cannot be stated that the authors' presentation of their subject is so simple as to render it easy to comprehend the phenomena described, but the close attention which is called for in reading the text results from the complexity of the subject and the technical vocabulary necessary in discussing it.

The chapters of direct practical interest deal with the history and genetics of selected flowering and ornamental plants, vegetable and salad plants, and fruits, and with

bud-sports, variations and fluctuations. These follow an account of the genetical and cytological principles which underlie the phenomena described, and it is in this part of the book that we have authoritative statements of the present views of the gene and the interaction of genes, the cytology of diploid plants and the cytology and genetics of polyploids. The phenomenon of polyploidy calls for special consideration in view of the part it plays in accounting for the departures from simple Mendelian inheritance which are so often encountered in plant-breeding practice. The book includes also chapters on Incompatibility (commonly known as "self-" and "cross-sterility") and Sterility (generational and morphological) which are of such great importance in commercial horticulture.

The authors have wisely compiled a glossary of technical terms and a valuable bibliography.

Scientific Horticulture (Formerly the H.E.A. Year Book). The Journal of the Horticultural Education Association. Volume III. 1935. Hon. Editor: R. T. Pearl, B.Sc., A.R.C.S., D.I.C. Pp. xliv + 228, $9\frac{3}{4} \times 6$. (Wye, Kent: The Editor, *Scientific Horticulture*, S.E. Agricultural College, 1935.) Price 3*s.* 6*d.*

The Editor claims that the change of title is justified because scientific method is becoming a principle of successful management and because scientific horticulture is the *raison d'être* of the Horticultural Education Association. The contents indicate that the claim is well founded. In his Presidential Address on Science and Fruit Growing, Dr. T. Wallace of Long Ashton reviews the progress made during the last forty years, and Messrs. R. T. Pearl and R. Hart summarise the important contributions made by the East Malling Research Station.

The part played by a University in linking up science with practice is illustrated by the inclusion of fifteen papers read at the second revision course for County and other horticultural officers held at the University of Reading in 1934. The course, devoted to vegetable and bulb production, was opened by Mr. H. V. Taylor with an account of the Vegetable Industry of To-day, and followed by valuable papers on the cultivation of vegetables, in the open and under glass, manuring, diseases and pests, canning, etc. Bulb production, diseases and the commercial aspects of the home industry were also fully dealt with.

Of special interest in this series of papers is that by Mr. F. A. Secrett on his overhead method of irrigating

vegetable crops with water which has been aerated and to which controlled small quantities of fertilisers have been added.

Other papers of value deal with commercial horticulture in Northern Ireland, research at Rothamsted of value to horticulture, and the utilisation of waste products as humus.

Larger type and more illustrations are noteworthy improvements in this very useful annual publication.

PROCEEDINGS OF THE ASSOCIATION OF ECONOMIC BIOLOGISTS, COIMBATORE. Volume I (1930–33). Pp. 102, $9\frac{3}{4} \times 6\frac{1}{2}$. (Coimbatore, Madras: The Association, 1934.) Price 1 Rupee.

The Association of Economic Biologists, Coimbatore, held its inaugural meeting in June 1930, under the Presidency of Dr. T. V. Ramakrishna Ayyar. Its purpose is "to promote the cause of Applied Biology in all its aspects," and the wide range of subjects dealt with in the papers and lectures included in this first volume of its "Proceedings" shows how well the Association is carrying out its object. Most of the contributions are given in abstract, with a reference to the periodical in which they were originally printed (in most cases the *Madras Agricultural Journal*) but the hope is expressed that future volumes will be more complete and self-contained. Three of the papers read during 1933 are reproduced in full, viz. "Some Introduced Weeds of South India," by C. Tadulingam and G. V. Narayana; "The Problem of Selection for Yield in Hybrid Progenies," by V. Ramanathan; and "Some Aspects of Drought Resistance, with Special Reference to Cotton," by S. Sankaran.

LA CULTURE DU RIZ DANS LE DELTA DU TONKIN. Étude et Propositions d'amélioration des Techniques traditionnelles de Riziculture tropicale. By R. Dumont. Pp. 435, $9\frac{3}{4} \times 6\frac{1}{2}$. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1935.) Price Fr. 50.

This volume deals with the special circumstances controlling the cultivation of rice in Tonkin where the crop is raised to meet the needs of the dense rural population of the district, in contrast to the rice-producing areas of Southern Indo-China which are concerned more particularly with supplying the overseas market.

A general account is given of the climate, soil and waterways of the region, and of the economic conditions of the people. Then follow chapters dealing with the local races

of rice, and the practice followed in respect of irrigation, transport, preparation of the soil, manuring, seed-sowing, planting, weeding, harvesting, thrashing and preparation of the rice for local use. There is also a chapter on the cultivation of "dry" rice and of other foodstuffs and of certain industrial plants grown in the region. An account of the pests and diseases of rice in Tonkin, by M. J. Nanta, is given in an Appendix.

Although, as will be seen, this work is purely local in character, those engaged in the production of rice in other countries will doubtless find in it much to interest them as bearing on their own problems.

AIDS TO THE ANALYSIS OF FOOD AND DRUGS. By C. G. Moor, M.A., F.I.C., and William Partridge, F.I.C. Fifth Edition, revised and partly re-written by John Ralph Nicholls, B.Sc., F.I.C. Pp. viii + 322, $6\frac{1}{4} \times 4$. (London: Baillière, Tindall & Cox, 1934.) Price 5*s*.

On account of the progress made in analytical methods, the issuing of fresh regulations relating to foods and the publication of a new edition of the *British Pharmacopœia*, it has been necessary to revise the fourth edition, published in 1918, of this well-known book. Although the general plan of the earlier edition has been maintained, it has been found desirable to introduce some re-arrangement of the contents.

Among the most important alterations made are those consequent upon the changes incorporated in the new *Pharmacopœia*. Special consideration has been given to the Public Health Regulations dealing with preservatives in foods and the requirements of the Agricultural Produce (Grading and Marking) Regulations. Recent methods of analysis have been included and the comprehensive work of the Committees of the Society of Public Analysts has been incorporated. The section on poisonous metals has been largely re-written and a new chapter on the analysis of unknown drugs has been introduced.

The new edition of this book maintains the high standard of the earlier ones and will be of considerable value to those engaged in the analysis of foods and drugs.

THE SOYA BEAN: ITS HISTORY, CULTIVATION (IN ENGLAND) AND USES. By Elizabeth Bowdidge. Pp. xii + 83, $7\frac{1}{2} \times 5$. (Oxford: The University Press; London: Humphrey Milford, 1935.) Price 6*s*.

Soya beans are one of the major oil-seed crops of the world. The bulk of the supplies are produced in Man-

churia, the annual output being estimated at over five million tons. The bean is indigenous to Eastern Asia, but many attempts have been made to acclimatise the bean in other parts of the world. These efforts have been particularly successful in the United States and Canada, where the crop is now grown commercially.

In England, acclimatisation experiments were started many years ago, but without much success, and it appeared to be the general opinion that the soya bean was unsuited to this climate. In 1933, an important experiment was carried out on an estate at Boreham, Essex, owned by Mr. Henry Ford. A successful crop of soya beans was raised from seed obtained as the result of many years' selection work by Mr. J. L. North, late Curator of the Royal Botanic Society of London. The experiment was repeated in 1934 on a commercial scale and an area of twenty acres yielded an excellent crop.

In the book under notice a full account of these experiments is given, together with descriptions of the varieties of bean planted. As the author's purpose is primarily to interest agriculturists in the possibilities of soya beans in this country, she has included much other general information on the cultivation and uses of the soya bean. After a general introductory chapter, an account of the Essex experiments is given. Then follow general particulars of the requirements, cultivation and harvesting of the crop. The uses of soya-bean hay, straw, etc., the manufacture and uses of soya-bean oil and food products are dealt with in the concluding sections of the book.

The work has been excellently compiled and should fulfil its purpose of arousing interest in the possibilities of the cultivation of soya beans as a farm crop in this country.

THE AMERICAN VEGETABLE-SHORTENING INDUSTRY: ITS ORIGIN AND DEVELOPMENT. By G. M. Weber and C. L. Alsberg. Pp. xii + 359, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: P. S. King & Son, 1934.) Price 14*s*. (Fats and Oils Studies of the Food Research Institute, Stanford University, California.—No. 5.)

This volume is devoted to a comprehensive account of the origin and development of the vegetable-shortening industry in the United States of America. The products considered are those manufactured solid fats (other than pure lard) which in America are used in cooking. The subject is treated mainly from an economic standpoint, but the technological aspects are not overlooked, as they are dealt with in two appendixes comprising some fifty pages,

where a history of the technology of the shortening industry is given, together with a description of the mode of action of shortenings.

Consideration is given to the effect of the compound cooking-fat industry on hog farming in the corn belt and cotton-growing in the Southern States, and to the attempts which have been made from time to time to control the manufacture of shortenings by legislation. The influence of the shortening industry on the lard industry and the efforts being made by the latter to meet the competition of the compound products are discussed.

Besides the appendixes already mentioned, others are included giving excerpts from the United States Food Administration Reports; tables of statistics; and a glossary of terms, with brief descriptions of the raw materials of the industry, their sources and their principal uses.

The book, which is well printed and is furnished with about twenty charts in the text, is very informative and should be of interest and value to all those whose business deals with the manufacture or sale of vegetable cooking-fats.

THE SCIENCE OF RUBBER ("Handbuch der Kautschukwissenschaft"). Edited by Prof. Dipl.-Ing. K. Memmler. Authorised English translation. Edited by R. F. Dunbrook, Ph.D., and V. N. Morris, Ph.D. Pp. xvi + 770, $9\frac{1}{4} \times 6\frac{1}{4}$. (New York: Reinhold Publishing Corporation, 1934.) Price $15.00.

When Memmler's treatise appeared some four years ago there must have been many who wished for an English translation. Now, thanks to the initiative of the Research Staff of the Firestone Tire and Rubber Company, an English version has been published, each section of which has been translated by an expert.

The scope of the book ranges over the botany, cultivation, collection and preparation of rubber, its chemistry, vulcanisation and analysis, microscopy and pigment dispersion, the physics of rubber, and the recently developed, specialised equipment for physical testing. The value of the original sections is considerably enhanced by the numerous translators' notes which have been added to bring the subject-matter up to date, particularly in those fields which have developed most in the four years since the original German edition appeared, e.g. the compounding and utilisation of latex, and the manufacture of synthetic rubber.

References appear conveniently at the bottom of each

page, and all of them (1,850 in number) have been checked and, where necessary, corrected, by the translators. A particularly valuable feature of the work is a complete bibliography of rubber compiled by the Firestone Research Librarian.

Although the book is primarily intended for the rubber expert and technologist, it contains much that should be of interest to the layman.

THE NATURAL ORGANIC TANNINS. HISTORY: CHEMISTRY: DISTRIBUTION. By M. Nierenstein, D.Sc. Pp. vii + 319, $8\frac{3}{4} \times 5\frac{1}{2}$. (London: J. and A. Churchill, Ltd., 1934.) Price 21*s*.

The author of this work has been engaged for some thirty years in carrying out researches on the chemical constitution of the tannins. These substances form a heterogeneous group of compounds of very complicated structure, the study of which demands close application and unlimited patience.

The book summarises the knowledge hitherto obtained and gives full references to the publications containing the original communications. The tannins are classified as (1) condensed tannins, (2) hydrolysable tannins, and (3) unclassified tannins. The first class includes the catechins, catechu-tannins and other condensed tannins; the second class comprises gallotannin, acer-tannin, glucogallin and hamameli-tannin, the ellagitannins, the caffetannins and Paullinia-tannin; to the third class belong by far the greatest number of the tannins, and the nature of these has yet to be elucidated. The work constitutes an excellent monograph on the subject, and will be of great value to chemists interested in this branch of research.

The last chapter, written by Dr. Macgregor Skene, on the botany of the tannins is, as would be expected from the nature of the subject, the most readable part of the volume. It deals with the distribution of tannins in the vegetable kingdom, their location in the plant tissues, their origin and their behaviour in the metabolic processes of the plant, and their value to the plant in protecting it against the attacks of snails and other animals.

IDENTIFICATION OF THE COMMERCIAL TIMBERS OF THE UNITED STATES. By H. P. Brown, Ph.D., and A. J. Panshin, Ph.D. Pp. xxvi + 223, 9 × 6. (New York and London: McGraw-Hill Book Company, Inc., 1934.) Price 18*s*.

The American Forestry Series, of which the work under notice is the first volume, aims at presenting, in a series of

text-books and reference works prepared under a uniform plan, the most reliable data concerning the various branches of forestry as well as recording the results of practical experience and offering suggestions as to new methods which should be of assistance to the forester in his work. In accordance with this scheme the present book seeks to give the best available information necessary for the identification of the commercial timbers of the United States, and thus assist the teaching and working forester, the plant anatomist, the architect, the engineer, and even the interested layman in their varying requirements.

The authors have relied upon anatomical structure as the principal means of identification, and regard such evidence as the only really serviceable basis for the purpose. The opening chapter deals with the structure of wood, naked-eye characters being first discussed and followed by information regarding minute anatomy. Two " keys " for identification of the different woods are then given, the first being based on characters requiring not more than a pocket lens (giving a magnification of 10 diameters) for their recognition, the second key requiring the use of a low-power compound microscope (75 diameters). As in the case of all keys of this type, and especially those depending upon observations of magnified characters, the greatest accuracy is required on the part of the observer, but he will derive much assistance from the excellently chosen and well-reproduced photomicrographs of each timber which accompany the text. The keys are followed by anatomical descriptions of each wood under the headings of General Characteristics, Minute Anatomy, and Remarks, the last-mentioned commonly providing comparisons with other woods with which the species concerned is likely to be confused. The text concludes with a useful glossary of terms, a feature indispensable in a work of this kind.

THEORY AND PRACTICE OF SILVICULTURE. By Frederick S. Baker, F.E. Pp. xiv + 502, 9 × 6. (New York: McGraw-Hill Book Company, Inc.; London: McGraw-Hill Publishing Co., Ltd., 1934.) Price 30*s*.

In this, the second volume of the American Forestry Series, the author has planned a text-book on silviculture on somewhat new lines. He suggests that the justification for another book in any field of applied science lies more in the viewpoint and manner of presentation chosen by the author than in the demonstration of new facts or theories, and explains wherein the book now presented by him fulfils

these conditions. The most important innovation so far as American text-books are concerned is the treatment in one volume of both " silvics," i.e. the biological foundations of silviculture, and the practice of silviculture which hitherto has alone formed the subject-matter of the text-books. The biological chapters are therefore grouped in Part I (Plant Physiology) in which the basic physiological processes are first discussed and notes made of the influence upon each of the varying factors. Part II deals with forest ecology in chapters treating of forest types and sites, form, composition and density of stands, tolerance and succession, while silvicultural systems and related problems are discussed in Part III. Field studies, demonstrating the value of the existing forest as a source of knowledge, form the subject of Part IV and the concluding section is concerned with silvicultural literature. The author's treatment of a subject which is not easy to translate into the form of a text-book appears to have been very successful and should go far to secure for him his aim " to put old things together in a new way with the object of developing in the student an independent free-thinking and forward-looking common sense in silvicultural matters."

FOREST MENSURATION. By Donald Bruce, B.A., M.F., and Francis X. Schumacher, B.S. Pp. xiv + 360, 9 × 6. (London: McGraw-Hill Publishing Co., Ltd., 1935.) Price 21*s*.

This, the third volume of the American Forestry Series, is concerned with forest mensuration. In an introductory note the consulting editor states that the book is distinctly a pioneer work inasmuch as it advocates methods of training students in forest mensuration which are radically different from those hitherto generally adopted in American forestry schools though successfully used for years by the authors in their classes at the University of California. Briefly, the new methods are based primarily on a thorough training in the use of the standard instruments and other " tools " employed in field work, and on the devising and adapting of the facilities offered by new methods available from other sciences, and especially that of statistics which has developed the use of the standard deviation, frequency curve and other instruments of investigation which are applicable to forest mensuration. The thorough study of these methods by the student is recommended before dealing with the conventional sequence of work on scaling, estimating and growth studies: " an arrangement has been sought which will facilitate the progressive acquisition

of the ability to handle the tools of mensuration." The book is planned accordingly, but includes descriptions of field procedures which are quoted as examples illustrating the use of the methods described and not as the main theses. A special section deals with the Prediction of Growth and Yield which again illustrates the application of mensuration to the foresters' problems.

Silviculture of the Mixed Deciduous Forests of Nigeria with Special Reference to the South-western Provinces. By W. D. MacGregor, B.Sc. (Agric. and For.) Edin., Silviculturist, Nigeria. Oxford Forestry Memoirs, Number 18, 1934. Pp. 108, 10 × 7½. (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1934.) Price 15*s*.

Hitherto, the records of silvicultural studies of tropical forests of the Empire have been largely concerned with the forests of India and Burma, and such records relating to the valuable forests of British West Africa have been extremely rare. The memoir under notice is particularly welcome inasmuch as it indicates the serious interest that is now being taken in one of the most important forest areas of the West Coast and records most useful silvicultural observations and experimental work undertaken by the author. There can be no doubt of the practical value of the silvicultural treatment of the forests: to quote examples at random, reference may be made to the observations carried out on the rate of growth of leading tree species in the natural forests and under conditions of improvement (fellings and clearings) which show that in the latter case the acceleration of growth is at least 30 per cent.; and to the author's experimental proof of the marked superiority of stump planting over "baton" planting (using cuttings from tree branches) in establishing plantations.

The mixed deciduous forests of Nigeria are intermediate in type between the true deciduous forests of the more northerly areas and the true evergreen rain forests of the coastal regions. The rainfall varies from 50 to 70 inches per annum, and the general climatic conditions favour the optimum development of deciduous tree species. The forest, however, includes high forest trees of both the typical deciduous and evergreen formations, but differs from the deciduous forest in containing evergreen under canopies, and from the evergreen forest in possessing top canopies of deciduous trees. Many of the almost innumerable species of trees and shrubs are as yet un-

identified. Of the numerous natural orders occurring in the forest, Sterculiaceæ, Leguminosæ, Moraceæ and Combretaceæ are the most important, and of the species met with *Triplochiton scleroxylon* (Sterculiaceæ) and *Chlorophora excelsa* (Moraceæ) have the greatest range of distribution. Few of the trees are gregarious, some demand light, others are shade bearers and others are shade-bearing light demanders. This state of affairs indicates at once the difficulties of natural regeneration of the forests and the importance of silvicultural work of the type carried out by the author.

The main sections of the book deal with statistical investigations into the growth of trees in Nigeria, comprising studies of the rate of growth in plantations and in the natural forests ; experimental silviculture dealt with under the standard branches of such work ; a description of silvicultural characters of species, including both indigenous and exotic trees, the latter deserving particular attention ; and an illustrated description of seedlings. An appendix describes the soils at Olokomeji.

The book is illustrated with interesting photographs and cannot fail to be of great interest to all West African forestry officers and a stimulus to further work of a like kind.

British Guiana Timbers. By Gerald O. Case, F.S.E. Pp. 73, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Metcalfe & Cooper, Ltd., 1934.) Price 7*s*. 6*d*.

In recent years considerable attention has been drawn to the merits of British Guiana timbers, and the officers of the local Forest Department through their annual reports and by personal efforts in this country have given evidence of the resources of the forests of the Colony in valuable hardwoods. The result is that commercial interests are now much better informed as to the capabilities of the country as a source of useful timbers than was formerly the case. The author in the little book under notice brings together the results of much of the work recently carried out by the Forest Department in surveying certain forest areas in the Colony, and by technical authorities in this country and in Canada who have investigated the properties of selected timbers. A useful statement of present knowledge of the timber resources of the Colony and the prospects they present for commercial development is thus available : the somewhat disjointed presentation of the information is no doubt in part to be explained by the varying character of the recorded observations. In this latter connection it may be mentioned that some of

the strength values of timbers quoted by the author are open to criticism.

A short description of the climate and general conditions obtaining in British Guiana is followed by an account of the topography of the forest lands, the estimated volume of standing timber, and the accessibility of supplies and methods of exploitation. The author points out that large areas of the best timber lands are adjacent to the Essequebo River or its tributaries, the Marazuni and Cuyuni Rivers, and quotes the Forestry Department in support of the statement that an enormous amount of timber can also be extracted with only a very few miles of logging railway.

A section dealing with market considerations discusses the reasons for the limited demand for British Guiana timbers hitherto and the probable future markets in the West Indies and the United Kingdom. The Forest Department has already pointed out that the difficulty of establishing an export trade in timbers other than greenheart " is that there are no stocks, no certainty of regular supplies and above all no seasoned timber. These difficulties can be overcome." Recent work of the Department has shown that there is no insuperable technical difficulty in supplying seasoned timber, and the adoption by the Department of the grading rules for Empire hardwoods put forward by the Imperial Institute is a step which will prove valuable when export to this country is undertaken. The author devotes a section to an account of the uses of British Guiana timbers for construction and building purposes in which he draws freely upon the publications of the Imperial Institute, and also quotes reports of investigations carried out by the Institute on the value of selected woods as paper-making materials and as charcoals for use as sources of producer-gas fuel for internal-combustion engines.

Buch der Holznamen. By Dr. Hans Meyer. III. Ishan—Mureré vermelho. Pp. 120, 10 × 7. (Hannover: Verlag von M. & H. Schaper, 1934.) Price M. 6.50.

This (third) part of Dr. Meyer's dictionary of wood names which carries the list practically to the end of the letter " M " maintains the excellence of the earlier parts referred to in this Bulletin (1933, **31**, 609), and increases the desire to have the complete work available. The care with which the local names of timbers have been collected is well illustrated by the inclusion of itiki boeraballi (Surinam), itiki bouraballi and itiki bourballi (British Guiana) as local names of *Machaerium schomburgki* Bth., and a series of some 114 entries of " Mahogany " indicates the

standard of completeness attained. It may be mentioned, however, that the botanical identity of "British Guiana mahogany" (crabwood) is given as *Carapa procera* DC., whereas the species commonly accepted as the origin of this timber is *C. guianensis* Aubl. Under "maple" no reference is made to Pacific maple, one of the trade names applied to Philippine lauan and Borneo seraya (*Shorea* spp.), but the omission may be in the nature of a protest on the part of the author against the coining of such undesirable names for commercial timbers.

SHEEP BREEDING AND WOOL PRODUCTION IN THE ARGENTINE REPUBLIC. By Professor Paul Link. Pp. 48, $10\frac{1}{2} \times 7$. (Argentina: The Author, Las Horas, 1743 Martinez, F.C.C.A., 1934.) Price 2*s*.

Professor Link states in the Preface to this monograph that his aim in writing it was "to offer to students, business men, manufacturers and breeders a description of Argentine sheep breeding and wool production from its early beginning up to the present day." The pamphlet, which is illustrated with photographs, maps and diagrams, fulfils this object in giving a concise survey, largely statistical, of the position of the industry during the last forty years, dealing not only with the numbers of sheep in the various provinces and territories of the country, but also with the relative importance of the different breeds and the production and exports of wool. A considerable amount of wool is now consumed in Argentine mills, but Professor Link is of opinion that notwithstanding this fact the exports will continue to be over 100,000 tons annually for many years to come.

VETERINARY HYGIENE. By Professor R. G. Linton, Ph.D., M.R.C.V.S. Second Edition. Pp. xix + 472, $9\frac{3}{4} \times 6$. (Edinburgh: W. Green & Son, Ltd., 1934.) Price 21*s*.

This work by the Professor of Hygiene at the Royal (Dick) Veterinary College, Edinburgh, is issued as a volume in the "Edinburgh Veterinary Series," published under the general editorship of the Principal of the College, Dr. O. Charnock Bradley. In the preface to the first edition, published in 1921, the author expressed the hope that the book would be of assistance to veterinary students, veterinary practitioners and others concerned with the well-being of animals, and the issuing of the present second and revised edition bears testimony to the success gained in these directions.

The contents of the volume are arranged in the follow-

ing main divisions : (1) "Water," dealing with the various types of water met with in veterinary practice and their filtration, sterilisation and examination ; (2) "Meteorological Phenomena and Instruments" ; (3) "Sanitation," describing methods of drainage and the treatment of sewage ; (4) "Air and Ventilation" ; (5) "Building Construction," a very lengthy section in which copious particulars are furnished of the types of buildings suitable for horses, cattle, pigs, poultry and other animals ; and finally (6) "Control of Disease," another long section, the amount of detail in which may be judged from the fact that the portion dealing with "Notifiable Diseases," whilst occupying 100 pages, treats only of animal diseases which are legally notifiable in Great Britain. Professor Linton explains that he has retained this particular sub-section as it may be helpful to students preparing for examinations and to the younger members of the veterinary profession engaged in demonstration work, but that he has omitted much that appeared in the previous edition on the subject of diseases as it is fully dealt with in other veterinary textbooks. Similarly, he has deleted the former section of the book on Sanitary Law, since when reference has to be made to an Act or to an Order a study of the original is the only satisfactory method of obtaining the desired information.

The work is deserving of the fullest commendation, not only for the authoritative and comprehensive nature of its contents, but for the very clear manner in which the various subjects are presented, the numerous useful illustrations and diagrams, and, finally, the excellence of the printing and production. In view of its size and utility, the price must be regarded as very moderate. The author, and the various collaborators whose assistance he acknowledges in the Preface, are to be congratulated on the production of so admirable a volume.

THE CARBOHYDRATES. By E. F. Armstrong, D.Sc., Ph.D., F.R.S., and K. F. Armstrong, M.A., B.Sc. Fifth Edition. Pp. vii + 252, $9\frac{1}{2} \times 6\frac{1}{4}$. (London, New York and Toronto : Longmans, Green & Co., 1934.) Price 15*s*.

The fourth edition of this monograph was published under the title of *The Simple Carbohydrates and the Glucosides* in 1924, and was reviewed in this BULLETIN (1924, **22**, 526). Since that year a large amount of fresh knowledge concerning these branches of organic chemistry has been acquired, and on this account it has been found necessary not only to re-write this work but also to divide it into two separate volumes entitled respectively *The Glucosides* and

The Carbohydrates. The former monograph was published in 1931, and the other is the subject of this notice.

The primary object of the authors of the present volume has been to deal with the subject of carbohydrates from a biochemical aspect, and they have therefore given special attention to a consideration of the natural sugars and their derivatives rather than to a discussion of intricate structural problems. At the end of each chapter is given a bibliography of the more important references in literature to the particular subject dealt with.

The monograph provides an excellent summary of the present information on the biochemistry of the carbohydrates and will be of great value to all those engaged in this branch of chemistry.

PRACTICAL EVERYDAY CHEMISTRY. By H. Bennett, F.A.I.C. Pp. xv + 305, $8\frac{1}{2} \times 5\frac{1}{2}$. (New York: The Chemical Publishing Co. of New York, 1934.) Price $2.00.

The contents of this book may be indicated by quoting the sub-title, which reads: "How to make what you Use. No Theory. Practical Modern Working Formulæ for making Hundreds of Products." The formulæ in question, with directions for their application, are classified under the following headings: Adhesives; Agricultural and Garden Specialities; Coatings, Protective and Decorative; Cosmetics and Drugs; Emulsions; Food Products, Beverages and Flavours; Inks, Carbon Paper, Crayons; Leather, Skins, Furs, etc.; Lubricants, Oils, etc.; Materials of Construction; Paper; Photography; Plating; Polishes, Abrasives, etc.; Rubber, Plastics, Waxes, etc.; Soaps and Cleaners; Textiles and Fibres; and Miscellaneous. From this it will be seen that a very wide field is covered.

In the Preface the author suggests that the work may have other uses besides the direct application of the formulæ, e.g. the acquisition of general information regarding the composition of manufactured products, the arousing of an interest in chemistry in young readers, new ideas for the manufacturer, etc.; and from these points of view the volume may prove to be of considerable utility.

INTRODUCTION AUX ÉTUDES MINIÈRES COLONIALES. Pp. viii + 349, $9\frac{1}{2} \times 6\frac{1}{2}$. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1934.) Price 36 Fr.

This, the fourth publication of the Bureau d'Études géologiques et minières coloniales, conforms to the general plan of the preceding volumes already noted in this

BULLETIN (1932, **30**, 528; 1934, **32**, 191 and 507). It represents a series of lectures delivered recently at the Natural History Museum, Paris, by twelve well-known experts on mining and geological problems relating to the French Colonial Empire.

The first chapter is by L. de Launay, who discusses the principal types of ore deposits and emphasises their very restricted occurrence. Then follows an interesting account by A. Lacroix on the tropical weathering of alumino-silicate rocks, with special reference to the formation of laterite and its allied deposits of bauxite and china clay. The study of alluvials from a practical point of view is next taken up by L. Thiébaut, who describes various ore-concentration methods, and furnishes good advice regarding the separation of minerals and their identification in the laboratory. Next comes a chapter on applied geophysics by C. Schlumberger, who summarises in two useful tables the more important method of geophysical prospecting and their specific applications.

Following this, P. Lecomte describes in some detail the organisation of a colonial mineral survey, while relevant subjects dealing with colonial hygiene, transport problems and relation with natives are considered by P. Noël Bernard, M. Maitre-Devallon and G. Hardy respectively.

Two chapters by André Duparque and J. Orcel deal respectively with the microscopic study of coals and of opaque minerals, and are illustrated by beautifully reproduced half-tone folding plates of micro-sections, excellent photographs and diagrams. The chapter by J. Orcel dealing with the microscopic study of opaque minerals is particularly useful; it contains a good description of the photo-electric ocular, which the author prefers to the well-known Berek slit micro-photometer.

The final chapters, by Jean Faye and A. Lambert-Ribot, are economic in their outlook, and deal with various commercial questions concerning minerals and metals in relation to France and her colonies.

The book well maintains the high standard set by previous memoirs in this series, and can be highly recommended to readers interested in French mineral resources.

CRYSTALS AND THE POLARISING MICROSCOPE. By N. H. Hartshorne, Ph.D., M.Sc., and A. Stuart, M.Sc., F.G.S. Pp. viii + 272, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Edward Arnold & Co., 1934.) Price 16*s*.

It is stated in the preface to this book that the "method of examining crystals which is afforded by the polarising microscope has long been indispensable to the petrologist

and the pure crystallographer, but the many and varied chemical applications of this method have not received the attention they deserve." Bearing this in mind, the authors, one of whom is a chemist, the other a geologist, have written an account of the theory and use of the polarising microscope, which should be very useful to chemists who have to describe new crystalline compounds.

Countless new compounds have been prepared in recent years, and vague terms, which are of little value to subsequent workers, are often used to describe their crystalline forms. Those who have endeavoured to identify a compound by means of the descriptions often to be found in the literature of the subject will hope that chemists will follow the practice recommended in this book.

The first three chapters deal mainly with crystal morphology and the optical properties of crystals ; the next contains a description of polarising microscopes, a number of types being dealt with and methods of illumination discussed. Then follow two important chapters on the examination of crystals with the microscope, both in parallel and convergent polarised light, including a good account of interference figures.

The book ends with examples of the use of the polarising microscope in both inorganic and organic chemical practice, and schemes are suggested for carrying out various optical determinations. A few experiments to illustrate typical methods of working are included.

Very few chemists receive adequate instruction in the use of the polarising microscope, and this book is accordingly to be recommended for its clear and concise treatment of this important aid to accurate diagnosis.

MODERN SURVEYING FOR CIVIL ENGINEERS. By Harold Frank Birchal, O.B.E., D.F.C. Pp. xi + 524, 8½ × 5½. (London : Chapman & Hall, Ltd., 1935.) Price 25s.

This work, by a former Chief Construction Engineer to the Kenya and Uganda Railways, is sub-titled " The Practice of Surveying, Estimating and Setting out Works of all Kinds, including Chapters on Modern Photographic and Aerial Surveying as applied to Engineering Enterprises." The author points out that there is a minimum of knowledge of surveying which a civil engineer must acquire, but that it is a waste of time to go beyond a certain point and that the essential requirements may be summed up as follows. The engineer must be capable of collecting sufficient data in the field, and preparing therefrom intelligent plans and sections for the purpose of laying out works and making

estimates of costs ; be competent to lay out works with the degree of accuracy necessary for the proper construction of such works ; and know when to utilise the services of specialists in aerial or photographic surveying.

The present volume, which has been compiled in consultation with several other experts with Colonial experience, contains a large number of useful diagrams and illustrations, in addition to the mathematical and other technical details essential to the subject. It should be of value to many civil engineers requiring a useful treatise on surveying, and should prove of special utility in connection with the construction of railways, harbours and irrigation works in the Colonies and Protectorates.

International Combines in Modern Industry. By Alfred Plummer, B.Litt., M.Sc. (Econ.), LL.D., Vice-Principal of Ruskin College, Oxford. Pp. ix + 191, $8\frac{1}{2} \times 5\frac{1}{2}$. (London : Sir Isaac Pitman & Sons, Ltd., 1934.) Price 7*s*. 6*d*.

This work deals with a subject which is of no small importance in international economics, but regarding which, as the author indicates in his Preface, it is difficult to obtain full or reliable particulars. The book opens with an introductory survey, following which there are chapters dealing with types of industrial combines, and their formation ; markets, tariffs and quotas ; the effects and tendencies of industrial combines ; and the future prospects of such organisations.

A large amount of information is given in the book, and it can be recommended to students of political and social economy as a concise and useful presentation of the subject.

BOOKS RECEIVED FOR NOTICE

Le Bananier et son Exploitation. By D. Kervégant. Pp. viii + 578, $10 \times 6\frac{1}{2}$. (Paris : Société d'Éditions Géographiques, Maritimes et Coloniales, 1935.)

Diseases of the Banana and of the Manila Hemp Plant. By C. W. Wardlaw, Ph.D., D.Sc., F.R.S.E. Pp. xii + 615, 9×6. (London : Macmillan & Co., Ltd., 1935.) Price 30*s*.

THE PRACTICE AND SCIENCE OF BREADMAKING. By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C. Pp. 184, $8\frac{3}{4} \times 5\frac{1}{4}$. (Liverpool: The Northern Publishing Co., Ltd., 1934.) Price 7*s.* 6*d.*

A HISTORY OF FOOD ADULTERATION AND ANALYSIS. By Frederick A. Filby, M.Sc., Ph.D. Pp. 269, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: George Allen & Unwin, Ltd., 1934.) Price 10*s.*

SHELLAC. ITS PRODUCTION, MANUFACTURE, CHEMISTRY, ANALYSIS, COMMERCE AND USES. By Ernest J. Parry, B.Sc. (Lond.), F.I.C., F.C.S. Pp. xi + 240, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd.) Price 12*s.* 6*d.*

THE PRACTICE OF SILVICULTURE, with Particular Reference to its Application in the United States of America. By Ralph C. Hawley. Pp. xv + 340, $9 \times 5\frac{3}{4}$. Third Edition, Rewritten and Reset. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 20*s.*

MANAGEMENT OF AMERICAN FORESTS. By Donald Maxwell Matthews, B.A., M.S.F. Pp. xv + 495, 9×6. (London: McGraw-Hill Publishing Co., Ltd., 1935.) Price 30*s.*

PRIMITIVE LAND PLANTS, ALSO KNOWN AS THE ARCHEGONIATÆ. By F. O. Bower, Sc.D., LL.D., F.R.S. Pp. xiv + 658, 9×6. (London: Macmillan & Co., Ltd., 1935.) Price 30*s.*

DICTIONARY OF TERMS RELATING TO AGRICULTURE, HORTICULTURE, FORESTRY, CATTLE BREEDING, DAIRY INDUSTRY AND APICULTURE IN ENGLISH, FRENCH, GERMAN AND DUTCH. Compiled by T. J. Bezemer. Pp. vii + 1059, $8 \times 5\frac{1}{4}$. (London: George Allen & Unwin, Ltd., 1934.) Price 25*s.*

THE GEOLOGY OF BURMA. By H. L. Chhibber, Ph.D., D.Sc., F.G.S., F.R.G.S., with contributions by R. Ramamirtham, M.A. Pp. xxviii + 538, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Macmillan & Co., Ltd., 1934.) Price 30*s.*

THE MINERAL RESOURCES OF BURMA. By H. L. Chhibber, D.Sc., Ph.D., D.I.C., F.G.S., F.R.G.S. Pp. xv + 320, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Macmillan & Co., Ltd., 1934.) Price 18*s.*

STRUCTURAL GEOLOGY WITH SPECIAL REFERENCE TO ECONOMIC DEPOSITS. By Bohuslav Stoces and Charles Henry White. Pp. xv + 460, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1935.) Price 25*s.*

A Comprehensive Treatise on Engineering Geology. By Cyril S. Fox, D.Sc., M.I.Min.E., F.G.S. Pp. xv + 392, $9\frac{3}{4} \times 6$. (London: The Technical Press, Ltd., 1935.) Price 35*s*.

The Elements of Practical Flying. A Detailed Survey for Students and Air Pilots. By P. W. F. Mills. Pp. vii + 133, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: The Technical Press, Ltd., 1935.) Price 4*s*. 6*d*.

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VOL. XXXIII. NO. 2

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

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PIASSAVA FROM SIERRA LEONE

THE piassava produced in West Africa generally is of inferior value to that coming from Brazil. This is in part due to the fact that the palms yielding the product in the two regions differ botanically, with a consequent intrinsic difference in the nature of their fibres. The West African piassava, nevertheless, is capable of much improvement by better methods of preparation and grading. This fact was realised by the Department of Lands and Forests in Sierra Leone some years ago and an energetic campaign was started by its officers with a view to devising improved methods and bringing them to the attention of the local producers (see " Piassava Industry in Sierra Leone," by Dr. F. J. Martin, *Bulletin No.* 5, 1928, Department of Lands and Forests, Sierra Leone).

A considerable number of experiments have been carried out by the Department, and samples of the piassava produced have been sent to the Imperial Institute for examination, particulars of which are given below.

Report No. 1

A full report on forty-six samples, received in February 1926, was published in Dr. Martin's *Bulletin* mentioned above. The material had been prepared in different ways from various parts of old and young leaves of the two species of *Raphia* occurring in the Colony, viz. *R. Gaertneri* and *R. vinifera*. The general conclusions arrived at may be summarised as follows.

The results of the investigation indicated that in order to prepare piassava satisfactorily the leaf stalks must be

retted for at least two months and in some cases for an even longer period. Judging from the appearance of the samples it would seem that the fibre from the front and middle parts of the leaf stalk is more readily retted and cleaned than that from the back and sides.

The sides of the leaf stalk appear to yield strands of more uniform strength and resilience for a greater length than those derived from the front and middle.

As a rule the darker fibre is more resilient, but the thicker dark-coloured strands are inclined to become woody and brittle. The back of the stalk yields the thickest woody fibre.

On the whole the best fibre was from the sides and front of the leaf stalk, whilst the middle fibre was in most cases of a weak, straw-like nature. It seems doubtful whether the separate treatment of these different parts of the leaf stalk would repay the additional labour involved.

In general the fibre from *R. Gaertneri* appeared to be of rather better quality than that of *R. vinifera.*

Report No. 2

A further series of eighty-four samples was forwarded in August 1931. They were stated to have been prepared from the leaf stalks of *Raphia vinifera* by retting in brackish water.

The samples were divided into three series, consisting respectively of fibre from over-mature, mature and under-mature leaf stalks; each series was sub-divided into seven sets (of four samples each) representing fibre from stalks retted for seven different periods ranging from twenty-one to 105 days. The four samples in each set were respectively from the back, front, sides and heart of the stalks.

It was stated that in preparing the samples the stalks were split into longitudinal sections; the sections from the back, front, sides and heart were then made into separate bundles and placed to ret in brackish water. After the bundles had been in the water for twenty-one days each was examined and a small quantity removed, the fibre being then separated and cleaned by the usual native methods. This process was repeated at intervals of fourteen days.

Piassava, in the condition in which it arrives in this country, is not usually bought by brush-makers, but is purchased by firms who sort it, dress it, cut it into the required lengths and dye it when necessary. The dresser either imports the fibre direct or purchases it from the importer. For these reasons arrangements were made for the samples to be inspected by a piassava dresser, who expressed the following opinions on them.

Maturity.—There is no material difference in the general quality of the over-mature and the mature samples, but the fibre from under-mature leaf stalks is generally very inferior, of little market value and should not be produced for shipment.

Retting Period.—The fibre retted for twenty-one days is insufficiently cleaned, whereas that retted for sixty-three days and over is well cleaned. As the piassava has not suffered in strength through 105 days' retting, the leaf-stalks might safely be left to ret for this period, if it allows of a more ready cleaning of the fibre, and if so long a time does not prove uneconomical. The appearance of the fibre suggests that the over-mature leaf stalks retted less readily than the mature stalks, and that the fibre from them was thus more difficult to clean.

Grading.—The best fibre in the present set is that obtained from the sides of the leaf stalks ; that from the back and front is also good, but that from the heart is of little value. It is not, however, desirable to grade the fibre according to the part of the leaf stalk from which it is derived, but the whole of the fibre should be mixed together, as is usually done in commercial consignments. If the fibre from the sides were actually marketed separately it would be welcomed by the trade and would realise a higher price than the ungraded product, but the procedure would be unprofitable, as the remainder of the fibre (from the back, front and heart) would be thereby so depreciated in value as to more than counterbalance the extra profit on the fibre from the sides.

Similarly, if the heart fibre were removed the remainder would be rendered more valuable, but no market would be obtainable for the separate heart fibre, and the procedure would not be profitable. In ordinary commercial consign-

ments the heart fibre is sold in admixture with the rest and no objection is raised provided the proportion is not excessive.

Length.—The length of the present fibres is similar to that of commercial Sierra Leone piassava, but the trade would be glad to have longer fibre if such could be prepared without reducing the quality.

It was evident from the general appearance of the samples that considerable care had been taken in their preparation.

The fibre in each of the eighty-four bundles was usually more uniform in character, and better cleaned and prepared than the samples of piassava received at the Imperial Institute in 1926. Generally speaking, the set of twenty-eight samples prepared from the over-mature leaf stalks did not differ materially from those derived from the mature stalks, but there was a decided falling off in the quality of the corresponding samples prepared from the under-mature material. It seems clear, therefore, that to maintain a good standard of quality for Sierra Leone piassava the preparation of fibre from immature leaf stalks should be avoided. As in the case of the samples previously examined, the sides of the leaf stalks were found to furnish the best fibre. This fibre was invariably darker and usually harder and more resilient than the fibre from the other sections of the leaf stalks. In some cases, however, the fibre from the back was of equal hardness and scarcely inferior in resilience. In the earlier series of samples it was found that the fibre from the front of the leaf stalks was more satisfactory than that obtained from the back, the latter being usually rather woody and brittle. In the present set of samples this was not generally the case, the fibre from the back being often superior to that from the front. The fact, however, that the back fibre is not round like the fibre from the other sections of the leaf stalk, but flat or oval, and broader, might render it less valuable if an attempt were made to market it separately. The fibre from the heart, as previously observed, was much inferior to that obtained from the other parts of the leaf stalk, being in most cases weak, brittle and straw-like, and of little or no value.

As regards the most suitable length of time for retting, this apparently would depend entirely on the readiness with which the fibre can be thoroughly cleaned. As most of the present samples were well cleaned and none of them had suffered through over-retting, it is rather difficult to express a definite opinion on this point. So far as could be judged from the appearance and quality of the samples it would seem unnecessary to continue the retting beyond the sixty-three-day period.

The present fibre was appreciably shorter than most of the samples previously received from Sierra Leone, many of which measured 4 ft. or more. As pointed out by the piassava dresser who was consulted regarding the materials, the trade would prefer longer fibre, which would command higher prices owing to the fact that less wastage takes place when the fibre is trimmed down to the required lengths.

Report No. 3

In January 1933, twelve samples of piassava, obtained from areas supplying the Sulima market, were sent to the Imperial Institute. It was stated that Sulima piassava had for some years been considered by buyers to be of inferior quality, with the result that it had been quoted at lower prices than other kinds exported from Sierra Leone, and the Department had accordingly been instructing the natives in methods of preparation in order to improve the quality of the product. The present samples, representing piassava prepared by native producers under instruction, were forwarded in order that they might be valued in the United Kingdom, and the attention of buyers called to the improved material that could be obtained by improved methods, in the hope that by this means the demand for Sulima piassava might be increased and the market value enhanced.

The table on page 128 shows the characters of the samples as found on examination at the Imperial Institute.

The samples were submitted to importers in London, who furnished the following observations on their quality and value :

" The samples of Sulima piassava sent for inspection are all of good quality, the percentage of brittle fibre being

Sample.	Length of fibre.	Thickness of fibre.	Colour.	Resiliency.	Remarks.
	in.	in.			
A. Gung, Soro	31 to 36	$\frac{1}{32}$ to $\frac{1}{10}$	Pale brown to purplish-brown; some fibre almost black.	Dark fibre, good. Light fibre, fair. A little soft and very weak fibre present.	Fibre apparently taken from all parts of the leaf bases in more or less equal proportions.
B. Jenneh Wo, Soro	33 to 36	$\frac{1}{16}$ to $\frac{1}{5}$	Mixture of pale yellowish-brown and purplish-brown; some fibre purplish-black.		
C. Samaru, Soro	33 to 36	$\frac{1}{32}$ to $\frac{1}{10}$	Mixture of pale yellow, reddish-brown and purplish-brown.		
D. Fairo, Soro	33 to 36	$\frac{1}{16}$ to $\frac{1}{10}$	Pale yellow and purplish-black.	Dark fibre, good; light fibre mostly weak.	do.
E. Tuasu, Makpele	33 to 37	$\frac{1}{24}$ to $\frac{1}{10}$	Pale yellow to reddish-brown.	do.	Good proportion of the better, darker fibre.
F. Gofor, Makpele	35 to 36	$\frac{1}{32}$ to $\frac{1}{10}$	Pale reddish-brown to purplish-brown.	Dark fibre good. Lighter fibre fair.	Consists apparently of fibre mostly from side, back and front of leaf bases.
G. Semabu, Kpaka	35 to 36	$\frac{1}{24}$ to $\frac{3}{32}$	Mixture of pale yellow, reddish- and purplish-brown.	Mostly good, but a small amount weak and brittle.	Similar to Sample A.
H. Baiima, Kpaka	34 to 35	$\frac{1}{20}$ to $\frac{1}{6}$	Mixture of pale yellow and reddish-brown.	On the whole fair. Lighter fibre soft, and dark fibre rather woody in places.	Rather a large proportion of the "paler," rather weak fibre.
I. Baoma, Massqquoi	33 to 36	$\frac{1}{24}$ to $\frac{1}{10}$	Mixture of pale yellow, purplish-brown and black.	Dark fibre good; light fibre weak and brittle.	Only a small proportion of the "paler," weaker fibre.
J. Juring, Gbema	35 to 36	$\frac{1}{24}$ to $\frac{1}{16}$	Reddish-brown to purplish-black	Dark fibre good, lighter fibre rather weak and brittle.	Similar to Sample H.
K. Foru, Gbema	33 to 36	$\frac{1}{24}$ to $\frac{1}{12}$	Pale yellowish-brown with a small amount of reddish-brown.	Partly fair; but paler fibre very weak and soft.	Fair amount of pale weak fibre.
L. Whi, Gbema	35 to 36	$\frac{1}{24}$ to $\frac{1}{10}$	Pale yellow, reddish-brown and purplish-black.	On the whole fairly good, with the exception of the yellow fibre.	Good proportion of the stronger, "dark" fibre.

small in comparison with present shipments of this grade. Generally speaking, the darker qualities are to be preferred, but it is unsatisfactory to judge the quality of this class of goods by such small samples, as it is doubtful whether bulk shipments would be as clean.

"This superior grading, as represented by these samples, would probably realise from 5 per cent. to 10 per cent. more than present F.A.Q. parcels, and it is possible, if shipments came fully up to the samples, that buyers would in course of time get more confidence in Sulima and pay higher prices."

The firm described and valued the samples as follows (April 1933):

Sample.	Description.	Nominal value per ton c.i.f.
A.	Lightish colour—strawy and part tender. Mixed texture	£14
B.	Fair uniform texture—and colour lightish. Some sticks	£14
C.	Mixed texture—bulk fairly light colour. Part tender	£13 10s.
D.	Mixed colour—part light, part dark. Somewhat mixed grading. Fair proportion strawy and tender	£12 10s.
E.	Mixed colour—part fine, part stiff. Fairly pliable, with part soft texture	£13 10s.
F.	UNIFORM LIGHT COLOUR—SOUND. Uniform texture and strong	£14 10s.
G.	Fair uniform colour. Stiffish, with part sticks or woody	£14
H.	Uniform light colour, but not pliable. This is of a strawy nature	£12
I.	BEST TYPE. UNIFORM COLOUR AND GRADING. SOUND	£14 10s.
J.	Lightish colour. Medium texture, but bulk tender	£12 5s.
K.	Mixed colour and texture. Part tender, but bulk selected and pliable	£13 15s.
L.	Fairly uniform light colour. Fine to medium texture	£13 5s.

The samples were also submitted to a firm of produce brokers in Liverpool who deal with a large proportion of the West African piassava trade, and who reported on them as follows:

"In appearance the samples are good and, being trimmed at both ends, appear equal to the best Sherbro piassava, which is commercially known as Prime Sherbro. The fibres are well cleaned, well trimmed, uniform in length and free of curly ends. This latter quality not only adds to the appearance but to the utility of the fibre commercially, because the work of the dresser, as a result, is rendered easier and there is not the waste involved. The fibres, for the most part, are of even texture or thick-

ness, being free from the very thick fibres and the fine fibres, although some of the samples contain rather more of one or the other than do some of the other samples.

"Compared with Ordinary Sulima, which is usually shipped, the samples are a great improvement. Ordinary Sulima is never so well cleaned and contains a considerable proportion of corky fibres, as well as thick, woody fibres, or butt ends, which are a great hindrance and require to be picked out by the dresser. There are some of these thick fibres, to which we are referring, in samples H, I and L.

"The colour on the whole is fair, inclined to be reddish-brown, but some of the samples contain too many yellow fibres, which are very strawy. When hanks are of mixed colour the whole requires dyeing and accordingly the more even the colour the better, sample F being a good example, and can be used without being dyed, whereas G would need immersion in a dye bath. The strawy fibres are useless and should be eliminated. This type is noticeable in samples D and J, and our opinion is that this is due to the fibre being immature.

"The quality to be aimed at in piassava is its pliability, and it is because of this that Sherbro piassava commands a premium over Sulima. Sherbro piassava is wiry and pliable. It must be borne in mind, when comparing Sulima with Sherbro, that the nature of Sulima piassava is different from that of Sherbro, and while some Sulima is undoubtedly fully pliable, as a fibre it is inclined to be on the weak side. In use, brush manufacturers add to Sulima, to stiffen it, fibres of other descriptions, chiefly Grand Bassa or Monrovian. On occasions, Sulima turns out very brittle, due, in our opinion, to poor drying or being left out in the hot sun to dry.

"Bearing in mind the difference between the characteristics of Sulima and Sherbro, the samples are excellent for Sulima, and while the fibres have not got the resiliency or spring of Sherbro, they are fairly pliable, although in one or two samples they are inclined to be on the weak side.

"Generally, the samples are very much superior to the Sulima which has been shipped in the past and it is probable that the samples will be superior to what can be shipped in a commercial way. If it were possible to make ship-

ments, equal in every way to these samples, there is no question of doubt that a considerable premium could be obtained over the price of Ordinary Sulima, but in view of the fact, as we have stated above, that there is a difference between the quality of Sulima and Sherbro piassavas, we do not think that Prime Sulima will ever command quite the same price as Prime Sherbro.

"The value of Ordinary Sulima to-day is very low, being £12 per ton c.i.f., and on to-day's market we would make the value of Sulima piassava, equal to the samples under review, say £16 to £17 per ton c.i.f.

"It is somewhat difficult on to-day's market to decide on which grade to base the value of this Prime Sulima, whether Prime Sherbro or Ordinary Sulima. The price of Ordinary Sulima is very depressed to-day owing to the exceptionally large quantities which are offering, but we do not think that if a basis of somewhere in the neighbourhood of £3 to £4 per ton below the price of Sherbro is taken, the price will be far out.

"Bearing in mind the general excellence of the samples, we give you below details of the faults to be avoided if possible :

A. Mixed colour, too much light.
B. Inclined to be light, some strawy, medium fibres, but too many thick.
C. Inclined to be too light and strawy.
D. Far too light and strawy, poor lot.
E. Mixed texture, inclined to be too thick. Only fair pliability, containing too much brittle.
F. Altogether good. The only fault is the few thick fibres.
G. Good, but inclined to be mixed in colour.
H. Far too light and containing much of the thick and stick-type fibre.
I. Too stiff and brittle, fibres too thick.
J. Very light and weak.
K. Mixed, inclined to be strawy, thick fibres.
L. Too many light strawy fibres and too thick."

All the present samples of piassava had been carefully prepared, and were generally of better appearance and

more thoroughly cleaned than samples previously received at the Imperial Institute from Sierra Leone. The fibre in all the samples was of mixed quality, but in general the resiliency was very satisfactory, as most of the samples did not contain any undue proportion of the weaker and brittle heart fibre. In most of the samples the fibre was of fairly even diameter, but a few contained some of the coarser black fibres derived from the back of the leaf bases. It might be desirable to make a separate grade of such fibre.

Report No. 4

A sample, representing piassava from the inland swamps of the Sierra Leone Protectorate, was received for examination and valuation in February 1935. It was stated that reports on preliminary consignments shipped by commercial firms had varied widely although the consignments were indistinguishable before shipment ; and it was therefore desired to receive an unbiased opinion on the quality and value of the present sample, in comparison with Prime Sherbro, Sulima and Opobo piassavas. In this connection it was pointed out by the Director of Agriculture that the material from the inland swamps (commonly known as " line " piassava) is bolder and of darker colour than the Sherbro variety, and it was thought possible that the conflicting nature of the reports received on the preliminary shipments might be due to certain firms who require light piassava, such as the Sherbro variety, not appreciating the heavier material now under consideration.

The sample consisted of piassava of rather mixed character, generally well cleaned, but of somewhat variable colour, being mostly reddish-brown or dark purplish-brown, with a few straw-coloured fibres. Most of the material was of good resiliency and toughness, but a few very coarse rather woody strips were present which were brittle and could not be bent without breaking.

The fibres showed considerable variation in width and length, ranging from $\frac{1}{20}$ to $\frac{1}{4}$ in. in width (mostly from $\frac{1}{12}$ in. to $\frac{1}{10}$ in.), and from 28 to 41 in. in length. Most of them were from 33 to 35 in. long and only a small proportion of shorter material was present.

Taken as a whole the material was much darker in colour than piassavas of the Sherbro and Sulima types which have been examined at the Imperial Institute, and possessed better resiliency and strength.

The piassava was submitted to (*a*) brokers, (*b*) piassava dressers, and (*c*) importers in London, who furnished the following reports respectively (April 1935) :

(*a*) " This sample represents a well cleaned and carefully prepared piassava, being somewhat smooth and pliable in texture. We consider there is a good prospect of business resulting, provided the bulk of the shipments were treated in the same manner, being careful to see same was carefully retted and cleaned before being bundled. We consider the value to be about £15 to £15 10*s*. per ton c.i.f."

(*b*) " We have examined the sample of swamp piassava and we consider that this would be worth some £2 per ton more than the usual grades of Sulima. It is a much stiffer fibre than either Sherbro, Sulima or Opobo, and is comparable only with Bassam or Fine Gaboon. We think it would find a ready market in reasonable quantities in this country."

(*c*) " We consider the quality suitable for this market. The to-day's values of the other qualities you mention are : Prime Sherbro £21 to £22, Sulima £12 10*s*. to £13, Opobo £21 to £22, and we consider the value of the ' line ' piassava, as per your sample, to be about £20 per ton c.i.f.

" We would be interested in offers of this quality."

This " line " piassava from Sierra Leone was of good saleable quality, and it is of interest to note that all three firms to whom it was submitted considered it to be worth more than ordinary Sulima piassava. In these circumstances it was suggested that a trial consignment of 1 to 2 tons of the fibre, equal in quality to the sample, might be forwarded to the Imperial Institute for disposal in London in order to test the market.

MYRRH FROM KENYA

For some time past the authorities of the Northern Frontier Province, Kenya Colony, have been investigating the possibility of exporting the gums and resins of commercial value which occur in that area. Of these it was considered that gum arabic must be excluded, as it could not compete with the Kordofan product at its present low price. It was thought, however, that something might be done with the more valuable myrrh and frankincense, commercial supplies of which come from the neighbouring country of British Somaliland. Two samples of myrrh were accordingly forwarded to the Imperial Institute by the Director of Agriculture, in January 1934, in order to ascertain whether the material would be of sufficient interest to be worth consideration for shipment to Europe. The samples were as follows :

A. Mandera District.—This consisted of material ranging from brittle, irregular lumps, 2 in. in diameter, down to small grains and powder. The colour varied from reddish-yellow to reddish-brown. The material was of dusty appearance and the fractured surface exhibited white markings. The odour was aromatic and the taste bitter.

B. Wajin District.—This material ranged from brittle, irregular lumps, 1½ in. in diameter, down to small grains and powder. The colour was reddish-brown and the appearance dusty. The fractured surface was harder than in the case of Sample A and exhibited no white markings. The odour was aromatic and the taste bitter.

The samples were examined with the following results, which are shown in comparison with those required for medicinal myrrh by the British Pharmacopœia (1932) :

	A	B	Requirements of the British Pharmacopœia.
	Per cent.	*Per cent.*	*Per cent.*
Matter insoluble in 90 per cent. alcohol	46·2	64·7	Not more than 70
Ash	4·5	6·5	Not more than 9
Colour reaction [1]	Positive	Positive	Positive

[1] *This test specifies that a violet colour shall be produced by the action of bromine vapour on an ether extract of the myrrh.*

These results show that the present samples conform in all respects to the requirements of the British Pharmacopœia.

The samples were submitted to a firm of brokers in London, who reported that they both represented saleable products, the current value of A being about 70*s*. per cwt., and that of B about 60*s*. per cwt., ex-warehouse London (April 1934). The firm stated that they would be glad to receive shipments of ½ ton of each variety, packed in 2-cwt. bags, for trial sale on the London market.

It will be seen from the foregoing results that both samples represented products which should be saleable in London, and it was suggested that if prices such as those quoted by the brokers appeared likely to render the collection of the materials remunerative, the suggested trial shipments should be forwarded to the Imperial Institute for transmission to the firm.

In February 1935, a trial consignment weighing about 5 cwts. was forwarded to the Imperial Institute by the Director of Agriculture.

The myrrh was mainly in the form of medium-sized and small irregular masses, yellowish-brown externally and dark reddish-brown within, together with smaller fragments, which were yellowish or brownish-orange, and some dust. The material was brittle, and the fractured surfaces were irregular and somewhat translucent. The main portion of the sample closely resembled the Aden myrrh of commerce, and was darker in colour than the two samples sent in 1934. The remainder resembled the sample from the Mandera District more closely than that from the Wajin District, but was not so reddish.

The sample was examined with the following results, which are shown in comparison with those obtained with the two samples received in 1934 and with the requirements of the British Pharmacopœia (1932) for medicinal myrrh :

	Present Sample.	Previous Samples.		Requirements of the British Pharmacopœia.
		A	B	
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Matter insoluble in 90 per cent. alcohol	60·2	46·2	64·7	Not more than 70
Ash	6·2	4·5	6·5	Not more than 9
Colour reaction	Positive	Positive	Positive	Positive

These results show that the present sample, like those previously examined, complied with the requirements of the British Pharmacopœia.

The myrrh was placed in the hands of the brokers who valued the previous samples, with a view to its disposal on the market at the best price obtainable. On inspection the firm described the material as follows:

"Small and rather dusty unpicked sorts, containing about 25 per cent. rough clinkery pickings. A small proportion is sea damaged and blocky—amounting to about 14 lb. in all."

The firm estimated the value of the myrrh at 60*s.* per cwt., but they eventually disposed of it in May 1935 at 67*s.* 6*d.* per cwt., a price intermediate between the values placed on the two samples which were forwarded from Kenya in 1934.

The firm stated that the material represented a fair marketable grade of myrrh, and they considered that further shipments, of ½ to 1 ton at a time, could be recommended.

OLEO-RESIN OF *EXCOECARIA AFRICANA* FROM KENYA

Excoecaria africana Muell. Arg. (= *Spirostachys africana* Sond.) is a deciduous or semi-deciduous tree, belonging to the natural order Euphorbiaceæ. It occurs in East and South Africa and extends westwards through South-west Africa to Angola. The wood is highly scented and is sometimes known in South Africa as "sandalwood" or "sandaleen," the native name there being "Tambuti." It is used as a substitute for the well-known Aloes wood (*Aquilaria Agallocha*) of India and in the manufacture of necklaces, charms, trinkets, small fancy boxes, etc. The wood has also been employed for gunstocks, furniture, and wagon-work. Accounts of the tree and its wood are given by Dr. J. Burtt-Davy in *Tropical Woods* (No. 17, 1929, p. 15) and by C. R. Metcalfe in *Kew Bulletin* (No. 1, 1933, p. 6).

In June 1933 a sample of the oleo-resin extracted from the wood by means of petroleum ether was forwarded to the Imperial Institute by the Senior Agricultural Chemist, Kenya Colony. A yield of 10 per cent. of the weight of the wood had been obtained.

The sample weighed 2 oz. and consisted of a reddish-brown, very viscous oleo-resin. The odour of the material was to a large extent disguised by that of petroleum ether (a little of which was still present in the sample), but the natural odour was more clearly revealed on warming. It was not very pronounced, though rather persistent and not unpleasant.

The oleo-resin was found to have the following constants :

Specific gravity at 15·5/15·5° C. .	1·068
Optical rotation α_D	− 4·2° at 24° C.
Refractive index $n_D 20°$ C.. . .	1·5243
Acid value	51·8
Saponification value . . .	83·2

The material was miscible with alcohol, and also with oil of turpentine, in all proportions. An alcoholic solution applied to a piece of sized wood formed a clear, lustrous, varnish-like coat, which took several days to become dry to the touch. A rather soft coat was eventually obtained.

On steam distillation the oleo-resin furnished 7·6 per cent. (equivalent to 0·76 per cent. from the original wood) of a pale brownish-yellow, very viscous, volatile oil. The odour of this oil resembled that of the oleo-resin, but, contrary to what might have been expected, was not appreciably stronger. The small quantity of oil available was insufficient for detailed examination.

The solid resin remaining after steam distillation was dark reddish-brown and brittle. It softened at 39° C. and was liquid at about 50° C. It was soluble in alcohol, and in oil of turpentine. A solution in alcohol applied to sized wood dried fairly rapidly, furnishing a rather dark, lustrous coat, of about the same hardness as that given by rosin.

The results of the examination showed that the material has the properties of a liquid oleo-resin or balsam and rather resembles Canada balsam. Like the latter, it dries

to a transparent varnish which apparently shows no tendency to crystallise, and it also possesses a high refractive index approximating to that of ordinary glass. It is possible therefore that the oleo-resin could serve in place of Canada balsam as a non-crystallising mounting medium for microscopical work, but the outlet for it in this direction would be small.

The odour of the oleo-resin does not appear sufficiently pronounced or attractive to render it of value in perfumery, except possibly as a fixative, and the product does not appear to possess any advantages over the commercial oleo-resins commonly employed for the latter purpose. A sample was, however, submitted for practical trials to a firm of manufacturing perfumers in London, who reported that owing to the nature of the oleo-resin they found it rather difficult to arrive at any definite opinion with so small a sample, but that they would carry out further trials if they could be supplied with a larger quantity.

Arrangements were therefore made for a further supply of the material to be sent from Kenya, and in September 1934 the Senior Agricultural Chemist forwarded a sample weighing about 1½ lb. This had also been extracted by light petroleum and consisted of dark reddish-brown oleo-resin. It resembled the earlier sample in odour, but was darker and considerably harder.

The material was found to have the following constants, which are shown in comparison with the corresponding figures obtained for the sample previously examined:

	Present Sample.	Previous Sample.
Specific gravity at 15·5/15·5° C.	1·112	1·068
Optical rotation α_D	(too dark to obtain reading)	− 4·2° at 24° C.
Refractive index $n_D 20°$ C.	1·5440	1·5243
Acid value	61·0	51·8
Saponification value	88·3	83·2

On prolonged steam distillation the material furnished 19·7 per cent. of a yellowish-brown volatile oil, as compared with a yield of 7·6 per cent. in the case of the earlier sample.

The oil was lighter in colour and considerably more viscous than that distilled from the previous sample. It was found to have the following constants :

Specific gravity at 15·5/15·5° C.	.	1·090
Optical rotation α_D	.	+ 14·87° at 17° C.
Refractive index $n_D 20°$ C.	.	1·5425

The specific gravity and refractive index of the freshly-prepared volatile oil are not markedly different from the corresponding figures obtained for the original oleo-resin. The viscosity of the volatile oil, however, increased markedly on keeping, and it seems not improbable that in time the oil would eventually become entirely resinified and be no longer volatile in steam.

The resin left after the removal of the volatile oil was dark reddish-brown and brittle, closely resembling that previously obtained. It softened at 41° C. and was liquid at 52° to 56° C., as compared with 39° C. and about 50° C., respectively, in the case of the earlier sample.

A sample of the oleo-resin, as received, was forwarded to the firm of manufacturing perfumers who, as stated above, had offered to carry out practical trials. They reported as follows :

" We have examined the sample from a perfumer's point of view. The most probable use of this oleo-resin would be as a fixative of soap perfumes, and to a lesser extent as a fixative in alcoholic perfumery. It would consequently have to compete with a wide range of balsams and resins, such as Balsam of Peru and tolu, styrax, labdanum, guaiacum and many others.

" The perfume is not similar to any balsam or resin we know, so it could not be used as a substitute for any product now in general use. At the same time the perfume is not, in our opinion, sufficiently characteristic to be of great interest on its own merits. We think, however, that it would be a useful addition to a perfumer's range of fixatives, in that it would blend with certain perfumes better than any existing fixative.

" The oleo-resin in its present form is soluble in essential oils, so it can be easily used in soap perfumes. It is, however, not sufficiently concentrated in perfume to use in alcoholic perfumes, as the amount that can be used is limited by the amount of resin which can be permitted in the perfume. If the volatile essence could be prepared

without the resin it could be used in alcohol perfumes and other perfumery.

"We have tried to obtain the volatile essence by distillation of the resin, but the result has not been successful, as the yield is too small. The essence, however, is rather of the vetivert type and would be quite useful.

"We think that the product is sufficiently interesting to justify a small quantity being prepared for sampling to soap-makers and perfumers, but it would be necessary to quote the price and give information as to how long it would take to produce quantities."

The firm expressed a provisional opinion that if the oleo-resin proved to be acceptable on the United Kingdom market it might be worth about 8*s*. per lb. under existing conditions.

The results of this investigation show that the characters of the sample differed to some extent from those of the material previously examined. The oleo-resin was considerably harder than the earlier sample, but it yielded more than twice as much volatile oil and the oil was considerably more viscous. Although the yield of volatile oil from the present sample is fairly high, it was only obtained at a very slow rate, a prolonged steam distillation being necessary. The production of the volatile oil would therefore probably be too costly to be remunerative on a commercial scale. The residual resin obtained on distilling off the volatile oil from the two samples was of similar character.

The results of the commercial enquiries indicate that the oleo-resin might be marketable in the United Kingdom as a fixative of a new character for use in perfumery, but in order to ascertain this it would be necessary to submit trial samples to a number of possible users.

PALMAROSA OIL FROM SEYCHELLES

The sample of palmarosa oil which is the subject of this report was forwarded to the Imperial Institute by the Acting Director of Agriculture, Seychelles, in March 1935.

The oil had been distilled from whole plants of palm-

arosa, grown from seed received from India, and a yield equivalent to 3 litres of oil per ton of material had been obtained. It was desired to ascertain the quality and market value of the oil.

The sample consisted of a clear, very pale yellow oil. It was found to have the following constants, to which are added those of three palmarosa oils from Seychelles previously examined at the Imperial Institute (see this BULLETIN, 1934, **32**, 517), and the ranges of corresponding figures recorded for Indian palmarosa oils :

—	Present Sample.	Previous Samples. A.	B.	C.	Recorded figures for Indian palmarosa oils.
Specific gravity at 15·5/15·5° C.	0·8886	0·9083	0·8960	0·8968	0·887 to 0·900
Optical rotation α_D	+ 0·41° at 20° C.	+ 3·1° at 20° C.	+ 0·03° at 24° C.	− 0·22° at 18° C.	+ 6° to − 3°
Refractive index n_D20° C.	1·4736	1·4796	1·4715	1·4722	1·472 to 1·477
Acid value	1·4	1·4	1·2	1·0	0·5 to 3·0
Ester value	29·2	46·1	97·2	90·3	12 to 48
Ester value after acetylation	272·0	262·3	276·1	273·5	226 to 274
Equivalent to "total geraniol," *per cent.*	94·0	89·8	95·8	94·6	74·8 to 94·8
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 1·6 vols.	Soluble in 1·6 vols.	Soluble in 1·8 vols.	Soluble in 1·6 vols.	Soluble in 1·5 to 3·0 vols.

These results show that the constants of the present oil fall generally within the ranges of figures recorded for Indian palmarosa oil. The oil, moreover, contained a high percentage of "total geraniol" and—unlike the two samples (B and C) dealt with in the previous report—a relatively small amount of esters.

The odour of the oil was very satisfactory and closely resembled that of a sample of a standard grade of Indian palmarosa oil with which it was compared. It was free from the pungency characteristic of gingergrass which has been observed in some of the palmarosa oils from Seychelles examined at the Imperial Institute.

The oil was submitted to a firm of essential oil distillers in London, who considered the odour to be almost identical with that of Indian palmarosa oil, with, if anything, a finer and cleaner bouquet. They considered that the oil

would be fully equal in market value to the Indian product, which was currently quoted at 6*s.* 3*d.* per lb. c.i.f. London (June 1935).

The foregoing results show that this sample of palmarosa oil is of good quality and comparable with the best Indian grades.

It may be pointed out that the yield of 3 litres of oil per ton (or about 0·3 per cent.) is unusually low. The yields obtained in India by the local direct-firing method are reported to vary between 0·3 and 1·0 per cent., whilst by steam-distillation as much as 1·3 per cent. may be secured.

CAMPHOR AND CAMPHOR OIL FROM MAURITIUS

It has long been known that certain camphor trees yield an oil from which no solid camphor can be separated. This is the case, for example, in Mauritius. Eight samples of the oil from that Colony examined at the Imperial Institute in 1912 and 1913 were all abnormal in character (see this Bulletin, 1916, **14**, 580), whilst of six samples received in 1927, only two yielded camphor when cooled to a very low temperature, and this only in very small amounts (1 to 2 per cent.). The Director of Agriculture informed the Imperial Institute in 1927 that out of 200 trees examined, only two were found to yield solid camphor.

In view of these results it was decided to carry out further experiments in Mauritius, and in 1927 seeds of *Cinnamomum Camphora* from trees known to yield solid camphor were imported from Formosa and planted at the Botanical Gardens, Curepipe (altitude 1,850 ft.) The trees have grown well and in 1931 they were pruned, and the leaves and twigs collected were distilled. The Chemical Division of the Department of Agriculture reported that out of 169 samples treated, seventeen gave oil only and the rest solid camphor. These oils were light-coloured and had a fine odour ; they had the following characteristics :

Specific gravity at 20° C. .	0·8831
Refractive index at 20° C. .	1·4669
Specific rotation . . .	+ 14°34′

The rotation of the oils is of interest as the typical Mauritius camphor oils are lævo-rotatory.

In 1934, the distillation was carried out on a larger scale (785 kilos. of leaves and twigs being treated), and a yield of 1·4 per cent. of solid crude camphor was obtained.

A sample of this camphor, together with camphor oil which had been separated from it by filtration, was forwarded to the Imperial Institute by the Director of Agriculture in January 1935. The results of their examination are given below.

Crude Solid Camphor.—This sample consisted of a mass of small camphor crystals in a rather moist condition. On pressing a representative portion of the sample, 13 per cent. of oil and water (mostly the latter) was expelled.

Camphor Oil.—This was a clear, very pale greenish-yellow oil, from which a small amount of solid camphor had separated. On cooling the oil to 0° C. for several hours a further quantity of camphor separated. Together, these quantities amounted to a yield of 10 per cent. of solid camphor from the oil.

After removal of this 10 per cent. of solid camphor, the oil was found to have the following constants :

Specific gravity at 15·5°/15·5° C. .	0·9189
Optical rotation α_D . . .	+ 33·22° at 16° C.
Refractive index $n_D 20°$ C. . .	1·4754

By repeated fractional distillation of this residual oil, and cooling of the appropriate fraction, a further 26 per cent. of solid camphor (calculated on the oil as received) was obtained, making a total of 36 per cent. recovered from the original oil.

The results of the fractional distillation of the residual oil are shown on page 144, in comparison with figures obtained at the Imperial Institute for a sample of oil distilled from camphor leaves and twigs in Burma.

The light camphor oil, i.e. the fraction boiling at temperatures up to 195° C., had a specific gravity of 0·8617 at 15·5° C. This fraction was found to contain 2·0 per cent. of cineole as determined by the ortho-cresol method, equivalent to 0·5 per cent. of the original oil. It may be mentioned that in oil distilled from Indian-grown camphor leaves Simonsen found 0·7 per cent. of cineole,

Fraction boiling at	Present Sample. On residual oil after removal of solid camphor separated at 0° C.	Present Sample. Calculated on oil as received.	Burma Camphor Oil. On residual oil after removal of solid camphor separated at 0° C.	Burma Camphor Oil. Calculated on oil as received.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Up to 195° C.	25·7	23·1	31·0	29·1
195° to 225° C.	20·1	18·1	9·3	8·8
225° to 245° C.	2·7	2·4	5·2	4·9
Above 245° C.	15·2	13·7	18·6	17·5
(Camphor)	(28·8)	(36·0)	(28·3)	(32·6)
Total [1] .	92·5 [1]	93·3 [1]	92·4 [1]	92·9 [1]

[1] *The quantity of oil unaccounted for in each case represented losses sustained in the separation of the camphor by filtration and pressing. It is not possible to allocate these losses definitely to any particular fraction, but they would consist principally of camphor and oil from the fraction boiling at* 195° to 225° C.

calculated on the oil from which solid camphor had first been separated by cooling (*Indian Forest Records*, 1923, **9**, 25).

In order to ascertain whether any safrole was present in the oil, the fractions boiling at 195°–225° C. and 225°–245° C. were redistilled, and a fraction was obtained which boiled at 220°–240° C. and amounted to 1·6 per cent. of the original oil. This fraction was redistilled and separated into three fractions, boiling respectively at 220°–225° C., 225°–232° C., and 232°–240° C. These fractions were then examined for safrole by cooling them to — 20° C. for 17 hours. All three fractions remained liquid at this temperature, and as the solidifying point of safrole is about + 11° C. it is evident that the amount of safrole in the oil, if any, was exceedingly small.

The foregoing results show that the present sample of oil, as received, was similar in composition to ordinary camphor leaf oil and contained much camphor in solution. It was thus very different from the oils received at the Imperial Institute from Mauritius in 1927, which resembled eucalyptus oils and contained little or no camphor.

The yield of 1·4 per cent. of crude solid camphor obtained from the leaves by the Department of Agriculture appears very satisfactory, if, as is presumably the case, the figure is expressed on fresh green leaves containing 50 per cent. or more of water. This result is higher than most of the yields recorded from camphor leaves grown in other parts of the world, apart from the additional camphor

which could be obtained from the oil by fractional distillation. In this connection it is of interest to quote the following figures of the yield of camphor and oil obtained from air-dried [1] camphor leaves and twigs from St. Lucia and Uganda previously examined at the Imperial Institute:

Description of material.	Yield of solid camphor separated by filtration and expression.	Additional camphor obtained from residual oil by fractionation.	Amount of residual oil.	Total yield of solid camphor and oil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Air-dried leaves and twigs from St. Lucia containing 9 per cent. of moisture .	1·9	0·3	0·7	2·9
Air-dried leaves and twigs from Uganda containing 12 per cent. of moisture .	1·6	—	—	2·3

The present Mauritius oil differs widely from the commercial camphor oils marketed in the United Kingdom, which are fractionated products obtained by the redistillation of crude residual camphor *wood* oil from which all solid camphor has first been removed by filtration and pressure. In the case of Japanese camphor oil the operations of fractionation and the cooling of the fractions to separate the camphor are so effectively carried out that the final product contains little or no camphor. The principal commercial oils are Japanese "light" (or "white") camphor oil and "heavy" (or "brown") camphor oil. The "light" oil (specific gravity 0·87 to 0·91) would correspond to the first fraction obtained in the distillation of the present Mauritius oil, and consists of terpenes with some cineole.[2] The "heavy" camphor oil (specific gravity usually from 1·018 to 1·026) represents the higher-boiling fractions of the crude camphor wood oil, and is the chief commercial source of safrole, of which it contains from 25 to 35 per cent. This Japanese "heavy" oil thus differs from the higher-boiling fractions of the present leaf oil, which contain little or no safrole.

[1] Eaton (*Bulletin of the Department of Agriculture, Federated Malay States, No.* 15, 1912), has shown that air-drying of camphor leaves has no detrimental effect on the yield of camphor and oil.

[2] One sample examined at the Imperial Institute contained about 30 per cent. of cineole.

It may be mentioned that supplies of Japanese "heavy" camphor oil are becoming scarce in Europe, owing to the utilisation of the oil in Japan for the extraction of safrole and the manufacture of heliotropin.

In the United Kingdom the present impure sample of solid camphor would be now worth less than 2*s.* a pound (June 1935), which is the present comparatively low price of Japanese *refined* camphor, and at this price it seems doubtful whether its production in Mauritius would prove very profitable, especially in view of the fact that the yield of camphor from camphor leaves is small compared with the 3 to 4 per cent. or more obtained from the wood in Formosa.

As shown above, the present oil, if fractionated, in Mauritius, would yield an additional amount of solid camphor, and a low-boiling fraction would also be obtained which, like Japanese "light" camphor oil, could be utilised as a turpentine substitute. The present price in London of Japanese "white" camphor oil is 95*s.* per cwt. duty paid. The higher-boiling fractions would be of much less value than Japanese "brown" camphor oil as they contain little or no safrole.

The prospects of marketing camphor oil as represented by the present sample are not promising, as the camphor oils required by the trade are fractionated products. If it is not possible to undertake the fractionation in Mauritius, and it is desired to find a market for the unfractionated oil, it was suggested that a small trial consignment (1–2 cwts.) might be forwarded to the Imperial Institute in the first place to test the market. The price obtainable will probably depend on the amount of camphor present and the suitability of the oil for the preparation of liniments and embrocations.

ARTICLES

SCIENTIFIC ASPECTS OF CACAO FERMENTATION

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PART II

SUCCESSION OF ORGANISMS AND EXPLANATION OF HIGH TEMPERATURES

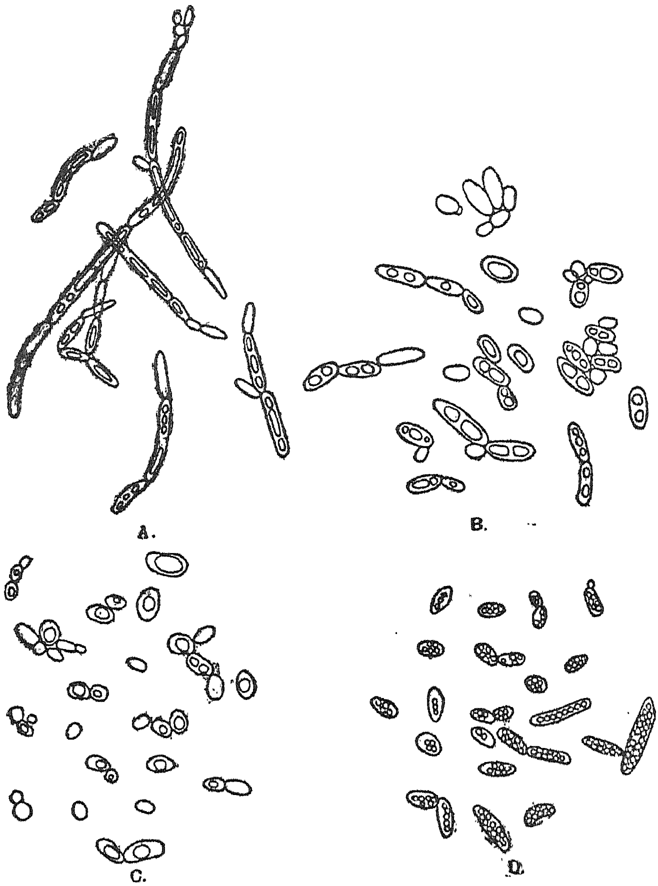
The Yeasts

THE order in which the different yeasts flourish is indicated in the table by Ciferri in Part I of this article (p. 43). In the early stages *S. anomalus* and members of the group known as *S. apiculatus* are predominant. *Eutorulopsis theobromæ* (Preyer's *Saccharomyces theobromæ*, discovered in fermenting cacao in Ceylon in 1901) is found throughout fermentation, and *Saccharomyces ellipsoideus*, *Schizosaccharomyces Bussei* and *Torulopsis Lilienfeld-Toalii*, are more abundant in the later stages. Ciferri worked on Forastero cacao. It is significant that Steinmann in Java —presumably working on Forastero-*Criollo* hybrid cacao— found *S. apiculatus* and *S. ellipsoideus* occurring in the same order during fermentation.

S. apiculatus has been observed at the beginning of fermentation in several other countries besides Java and San Domingo—namely, by Bainbridge and Davies [17] in Jamaica, Briton-Jones [22] in Trinidad, Ficker and Lilienfeld [32] in Bahia, and Henneberg [20] in cacao from the Cameroons. The more typical cells are lemon-shaped. As the cells cannot survive drying, *S. apiculatus* was not found on the dry cacao beans examined by Lilienfeld-Toal or by Henneberg. As shown in the table mentioned above, Ciferri found large numbers, but only at the beginning of the fermentation, of a new sub-species of *S. apiculatus*. This sub-species, which he named *Klockeria cacaoicola*, grows without difficulty in media containing 1 per cent. of acetic acid, and thus differs from the other species sometimes found by him in the early stages of fermentation, namely, *Klockeria domingensis*. The latter he found on rotting cacao pods, and he states that its growth is inter-

rupted by the feeble effective acidity which is represented by a hydrogen-ion concentration of pH 5·0 to 4·6.

In the later stages of fermentation *S. ellipsoideus* has been found in several countries besides Java and San



From "Fermentation of Cacao." By permission of John Bale, Sons & Danielsson.

FIG. 1.—CACAO YEAST, *S. THEOBROMÆ* PREYER (now called *EUTORULOPSIS THEOBROMÆ*)

A. C. D. × 800; B × 1,000.

A. Long mycoderm skin cells. B. Pure culture from pulp liquor.
C. Yeast sediment. D. Ascospores formed after eighteen hours.

Domingo—by Bainbridge and Davies in Jamaica and Briton-Jones in Trinidad. This yeast survives both fermentation and drying. Lilienfeld-Toal [23] found *S. ellipsoideus* and *Schizosaccharomyces Bussei* to be the most important yeasts found on the dry cacao beans of commerce.

The generally accepted importance of *S. ellipsoideus* has been questioned by Lilienfeld-Toal [34], in view of the fact that he found it could not by itself break down the pulp of the coffee bean, and therefore he considers it would be equally ineffective with the pulp of the cacao bean, as this is similar in composition.

In 1924 our knowledge of cacao yeasts was very incomplete and the author [12] called attention to the absence of a satisfactory explanation of the high temperatures that are maintained in cacao fermentation. It is well known that in the production of wine the action of the grape yeasts (*S. ellipsoideus*) is impaired above 40° C. and the temperatures which are favourable to cacao fermentation are those at which wine develops diseases.

More recent researches have shown that the optimum temperatures for cacao yeasts are high; Henneberg, working in Germany, found for *Eutorulopsis theobromæ* 30° to 37° C. and Ciferri, working in the tropics, 35° C. Lilienfeld-Toal, working in Germany on organisms from dried cacao beans, found the optimum temperature of *S. ellipsoideus* to be 20° to 30° C., Henneberg 30° to 37° C., whilst Ciferri, working in the tropics, found 40° C. Apart from this high optimum temperature Ciferri found this to be in all other respects a typical wine yeast. For *Schizosaccharomyces Bussei* Henneberg gives an optimum temperature of 37° to 40° C., and Ciferri gives 40° C. for both this and *Torulopsis Lilienfeld-Toalii*. These figures, especially those of Ciferri, help us to account for the high temperatures observed.

The production of alcohol and carbon dioxide from sugars is an exothermic reaction:

$$\begin{cases} C_{12}H_{22}O_{11} + H_2O & = 2\ C_6H_{12}O_6 + 4{\cdot}5 \text{ Cals.} \\ \text{Sucrose and water} & \quad \text{Invert sugar} \end{cases}$$

$$\begin{cases} C_6H_{12}O_6 & = 2\ CO_2 + 2\ C_2H_5OH + 22{\cdot}3 \text{ Cals.} \\ \text{Glucose} & \quad \text{Carbon dioxide and alcohol.} \end{cases}$$

As two of the most important yeasts have optimum temperatures of 40° C., we should naturally expect the fermenting mass to rise some degrees above this. The exact temperature produced, however, is influenced in the majority of cases by the development of acetic

acid bacteria, and in others by the development of mould.

In cacao fermentation in boxes in Trinidad the author noted that after the fourth day, although yeasts were still present, the predominating micro-organisms were non-motile rod-like bacteria, some isolated, others in pairs or chains. The temperature at this time was 48° or 49° C., at which temperature the ordinary acetic bacteria are impaired. On the Gold Coast in fermenting heaps, the temperature of which generally rises to 50° C. and often above, bacteria are nothing like so prominent, and in the case of the *unturned* heaps certain moulds are much in evidence in the later stages.

H. A. Dade in a private communication to the author writes that the predominant yeast in fermenting beans on the Gold Coast resembles superficially *S. theobromæ* Preyer, and has been determined by the experts at the Delft Laboratorium as a new species of *Mycotoruloides*. His other yeasts from cacao fermentations they identify as a new *Klockeria*, a new *Hansenula* and a *Mycoderma*.

H. A. Dade, in a laboratory fermentation, inoculated 60 lb. of cacao with a pure culture of *Saccharomyces cerevisiæ* Hansen, cacao strain, which he had previously found in anaerobic experimental fermentations. The temperature reached 50° C. in 72 hours, an exceptionally high temperature for a box fermentation. It would appear that the tropical variety of micro-organisms often has a high optimum temperature. (Incidentally the author examined the cacao produced and found it to be slightly better than the normal product of Gold Coast box fermentation. This experiment, and the effect of kinds of yeast on flavour, will be discussed later under variations on natural fermentation.)

With regard to the numerical survival of the yeast cells during fermentation, Bahia and the Gold Coast form a contrast. Whilst Ficker and Lilienfeld-Toal observed in Bahia that as the bacteria increased the yeast decreased until at the end of the fermentation only bacteria was found, Dade on the Gold Coast noted that whilst the number of bacteria increased (especially on the sixth day) the yeast cells were still present at the end in about their original numbers.

The Bacteria

Most observers have noted that the micro-organisms most in evidence in the early stages are yeasts, and that various bacteria make their appearance quite early and in the later stages predominate. These bacteria are of importance as having a considerable effect on the cacao produced. It is generally agreed that the most important are the acetic bacteria, but lactic acid bacteria are mentioned by some writers (e.g. Ficker and Lilienfeld-Toal), the latter [34] also mentions *Coli aerogenes*, and several agree that if the process continues too long there is a risk of butyric acid being developed. H. A. Dade, in a private communication to the author, has found *Bacillus undulatus* and *Bacillus megatherium*, but does not think that bacteria play a large part in Gold Coast fermentations.

In any case, if the fermentation be unduly prolonged, moulds and putrefactive bacteria appear. Bainbridge and Davies noted spore-forming bacilli of the *B. subtilis* type. C. Thom found aerobic spore-forming bacteria, including some of the mesenteric group.

In the author's opinion it is the presence of a minute quantity of butyric acid together with the result of mild putrefactive changes (with or without a suggestion of smoke acquired from the burning wood used in the artificial driers) that gives the cacao the peculiar flavour called " hammy " to which buyers object. This can be, and practically always is, prevented by stopping the fermentation at the right stage. Acetic acid fermentation cannot, however, be prevented under normal circumstances, and the acetic acid bacteria are therefore worth more detailed study. The question as to the good or bad effect of acetic acid production on the quality of the cacao will be considered later in the paper. At the moment we are concerned with the kinds of bacteria present and the part they play in the production of high temperatures.

The most complete examination of the acetic acid bacteria in relation to cacao fermentation is that carried out by C. Eckmann [25], who grew cultures in Prussia from the liquid from the fermenting beans, the dried beans of commerce and the fresh fruits sent to him from the tropics.

He found acetic bacteria on all the cacao beans from all countries tested. The flora were nearly the same in all countries; no typical tropical kinds were found, the species isolated being either the same or similar to European kinds.

Of acetic bacteria already known, *B. xylinum*, *B. xylinoides*, *B. orleanense* and *B. ascendens* were found. Eleven out of twenty of the varieties could grow under anaerobic conditions, but they were not typical anaerobic types. The optimum temperature of all the four species named above is 30° C., and in no case was an optimum temperature above this found. The maximum temperature of growth of the *B. ascendens* and *B. xylinoides* is 44° C.

The production of acetic acid from alcohol is an exothermic reaction and the oxidation of the alcohol produces considerably more heat than was given out by the production of this same alcohol from sugar:

$$\underset{\text{Alcohol and oxygen}}{CH_3CH_2OH + O_2} = \underset{\text{Acetic acid and water.}}{CH_3COOH + H_2O} + 118{\cdot}6 \text{ Cals.}$$

On the appearance of acetic acid during fermentation a further rise in temperature might therefore reasonably be expected, provided the temperature produced is not above that at which the acetic bacteria can thrive. If we assume that had the fermenting beans been tested in the tropics no further acetic acid bacteria would have been found, and that the optimum and maximum temperatures of those found would have been the same as above, then the amount of acetic fermentation that takes place in the later stages of cacao fermentation is difficult to understand, and the acetic bacteria can play little or no part in the temperatures of 48° C. to 50° C. which are often obtained and maintained. The old observers thought that high temperatures should be avoided as resulting in an acid product. Accepting the above temperatures, we should have to conclude that the acetic acid bacteria could be partly controlled by encouraging the rise of temperature to be as rapid as possible and then maintaining the high temperature during fermentation.

This does not accord with experience in most countries, and as Ashby [31] in Trinidad has recorded finding three kinds of acetic bacteria with an optimum temperature of

46° to 49° C., the author concludes that acetic bacteria with this high optimum temperature probably exist in many cacao fermentations where there is sufficient aeration, and are an important factor in producing and maintaining the high temperatures. The unturned native heaps on the Gold Coast may be an exception, for in this case moulds are partly responsible.

The Moulds

The subject of moulds in relation to cacao beans is an important one, for mould in the interior of the bean is the most serious of all defects. Microscopic examination has shown that moulds may occur in the fermenting mass, although in well-conducted fermentations never in sufficient quantity to be visible to the eye, save sometimes in patches on the side of the container. The appearance of moulds on the outside of the bean during drying is a normal phenomenon, but under good conditions the mould is no longer visible in the later stages, and its brief temporary appearance on the shell does not affect the quality of the cotyledons. As mentioned above, moulds which are present in badly conducted fermentations may result in the entrance of other moulds into the interior of the bean during drying and imperfect storage.

(1) *Mould seen during fermentation.*—Of the early observers, Chittenden and Preyer noted the appearance of Penicillium during fermentation. M. L. Lutz [35] was the first to identify a number of the moulds. He examined in 1906 fermented beans sent by A. Chevalier from San Thomé and found *Sterigmatocystis niger* (now generally called *Aspergillus niger*), *Sterigmatocystis luteo-niger* (the sterile mycelium of which is golden yellow), *Fusarium theobromæ* (with pale ochre mycelium), and *Pseudo-Absidia vulgaris*. L. J. Schwarz [18] sent from the Gold Coast to C. Thom specimens of cultures of yellow, greyish and other moulds which he noted where the beans came in contact with the box. Thom found *Aspergillus niger*, *A. flavus* and *A. tamarii* were abundantly present and that the *mucors*, especially the species of *rhizopus*, were also common.

R. H. Bunting [19] and H. A. Dade [30] have made together a most interesting contribution on moulds in relation to fermentation. Bunting found in fermenting heaps

on the Gold Coast, particularly when such masses had not been turned or disturbed, the glaucus mould, *Aspergillus fumigatus* (Fresenius group). It is absent from the centre of the heap and little developed at the bottom, probably being inhibited by the high percentage of carbon dioxide in those regions. It is of particular interest because it is thermogenetic, and in one mass where it developed the temperature rose to 54° C. Bunting also found, even more frequently, a second thermophile, a *cymo-Mucor*, nov. sp. 463, now called after the discoverer, *Mucor buntingii*, Lendner. It is evident that the high temperatures observed in unturned heaps on the Gold Coast are partly due to the development of these moulds. They can be seen on removing the covering of plantain leaves as grey patches on the surface of the mass of fermenting beans, the matted mycelium penetrating some inches into the heap.[1] A single turning or mixing of the heap generally causes sufficient aeration to prevent visible mould growth. The expression visible mould growth is used advisedly, for microscopic investigation would probably show that some mould is always present. The author has never seen this appearance in box fermentations in the West Indies or on the Gold Coast, and it is unlikely that moulds under these conditions of fermentation play an important part in the production of high temperatures.

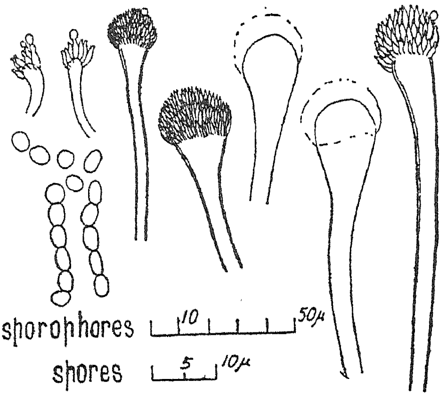


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FIG. 2.—*ASPERGILLUS FUMIGATUS*.

Thom and Church in their monograph on the Aspergilli record that certain members of the group, which includes *A. fumigatus*, have the power of destroying cellulose and pentosans. The main objection to *Aspergillus fumigatus* arises from this. H. A. Dade has proved that this mould

[1] For illustrations of this, see photo by Dade in *Gold Coast Year Book*, 1928, p. 91, and by the author in this BULLETIN, 1934, **32**, p. 416.

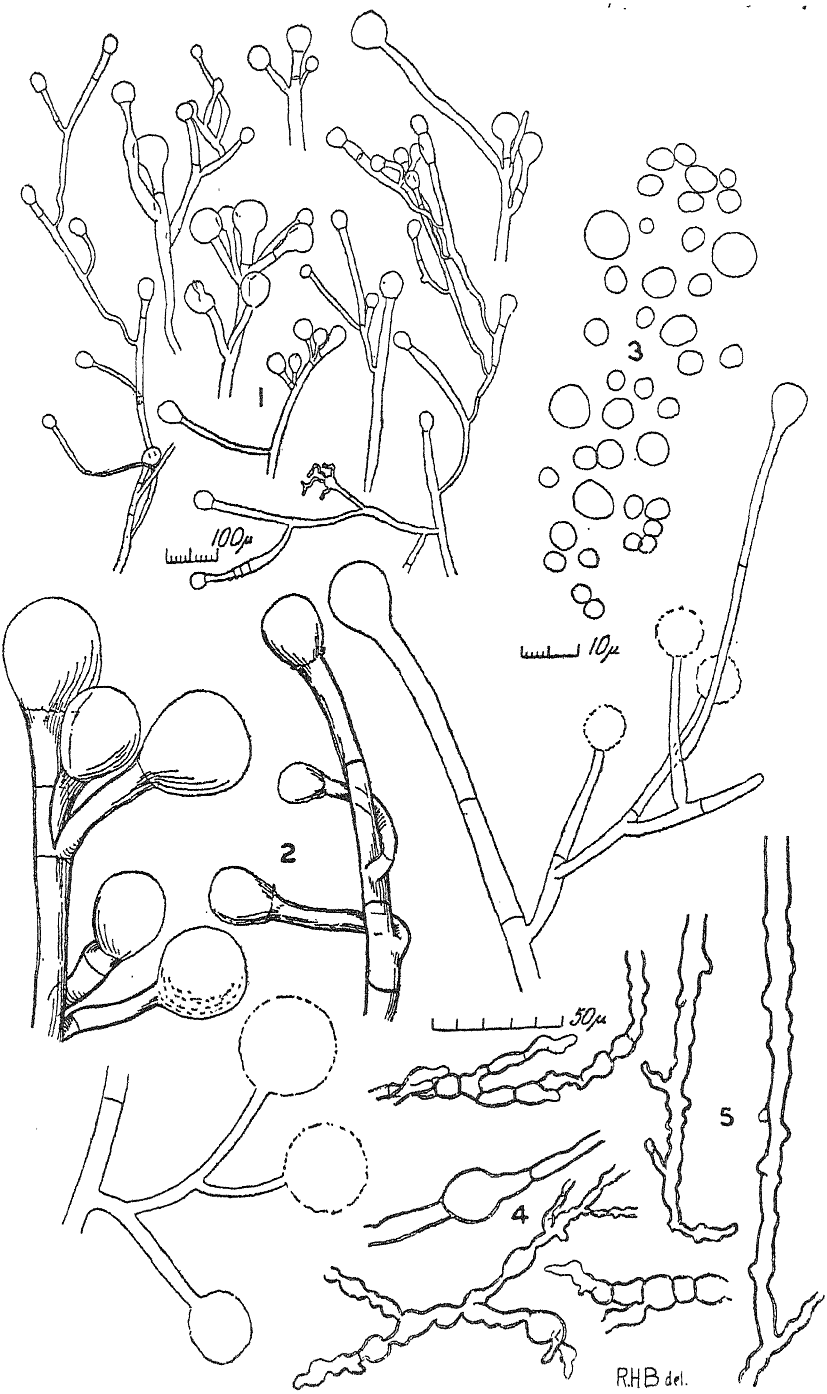

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FIG. 3.—*MUCOR BUNTINGII* LENDNER.

1 and 2. Sporangiophores. 3. Spores. 4. Mycelium with intercalary chlamydospore. 5. Basal end of sporangiophore from old cultures.

penetrates the weakened tissue opposite the tip of the radicle (or germ), spreads round the radicle and on the adjacent surfaces of the cotyledons. This opens the way for entry (to the interior of the bean) of the other moulds which are usually found on drying and dry cacao.

Steinmann [24] working in Java, where the cacao is the product of Forastero-*Criollo* hybrids, after 6½ days' fermentation, found *Aspergillus glaucus*, *Penicillium glaucum*, *Oidium lactis*, and a variety of mucor-forming zygospores. Ficker and Lilienfeld-Toal in Bahia noted mould fungi even from the beginning of fermentation.

The effect of acidity on moulding will be mentioned later under hydrogen-ion concentration.

Although in this paper we are concerned mainly with fermentation, as fermentation and drying are both parts of curing it will be well to include some notes on the moulds which are found on the dry cacao beans of commerce.

(2) *Mould on cacao beans after fermenting and drying.*—On dry Accra beans which had been stored, Bunting found chiefly *Aspergillus glaucus* and a species of Penicillium. On prepared beans with a high moisture content he found *A. niger* (three forms), *A. tamarii*, *A. flavus* (two forms) and *A. ochraceus*, and certain Mucoraceæ : a cymose species of *Mucor*, two species of *Absidia* and one of *Circinella*.

Aspergillus glaucus (now called *A. chevalieri*) is of particular importance in the commercial production of cacao because it can develop on cacao with considerably lower water content than any of the others ; it can grow on cacao beans which are nearly dry, that is, according to H. A. Dade, on cacao containing 8·5 to 9·0 per cent. of water.

Passmore [33] mentions that the following species have been isolated at the Stored Products Research Laboratories at Slough (presumably by Bunting) from beans from Africa and other places and have " not previously been reported as cacao saprophytes " : *Aspergillus gracilis*, *A. repens*, *A. ruber*, *A. sydowi* and *A. terreus* ; *Syncephalastrum cinerium* ; *Scopulariopsis* sp. : *Sporotrichum flavicans* var. ; *Penicillium citrinum* (or var.) and *Cylindrocarpon* (*Fusarium*) sp.

Other investigators who have isolated the moulds on

the cacao beans of commerce are Henneberg, Reinke, Laycock and Ciferri. Their results are briefly epitomised below.

Henneberg [20] isolated from African and American cacao beans green, brown and black kinds of Aspergillus, six Mucors (Rhizopus, etc., a brown kind survived 45° C.), seven *Penicillia*, three *Cladosporia*, together with *Oidium*, *Monilia*, *Cephalothecium*, *Fusarium* and *Botrytis*. The shining yellowish-green Aspergillus was the one most frequently found, the maximum temperature for which was 37° C., whilst the less common brown kind had a maximum of 45° C.

Reinke [21] made a very detailed study of the *Aspergillus* group. He examined 40 samples of beans from 18 producing areas. He obtained 142 strains of Aspergillus. In 75 per cent. of the samples he found *Aspergillus flavus* and *A. niger*. In 50 per cent. he found *A. tamarii* and *A. sydowi*. The first three frequently occurred in Accra cacao. He also found on the various cacaos : *A. repens, terreus, carbonarius*, and occasionally *versicolor* var. *flavipes, candidus, giganteus, ochraceus* and *versicolor*.

Laycock [28], who has published several studies of moulding of cacao in Nigeria, isolated several Aspergilli from mouldy cacao. The predominant one was *Aspergillus glaucus*. The others were identified by the Imperial Bureau of Mycology as *A. flavus*, Link. ; *A. fumigatus*, Fresen. ; *A. tamarii*, Kita ; and *A. sydowi*, Bain and Satory.

Ciferri [15] investigated Actinomyces in Dominican cacao, and found that it lives in an inactive form during fermentation and that any growth which takes place occurs during shipment. Its presence is very objectionable as it gives cacao a peculiar and disagreeable musty odour. If one can judge from a knowledge of the odour of commercial cacao, then in the author's opinion the presence of actinomyces is rare. In the Stored Products Research Laboratories according to Passmore [33], although many cacaos were examined, experience of musty West African beans was confined to a single Nigerian cacao. From this cacao three variants of a species of Actinomyces were isolated by Bunting [36] and have been described by S. Waksman and named *Actinomyces cacaoi* I, II and III.

Ciferri has done some good work on the moulding of cacao, but he is apparently unaware that his cacao is much damper than the average cacao of commerce which, as produced ready for bagging, generally contains less than 8 per cent. of moisture.

In a paper on " Cacao Moulding " he gives the moisture content of nine samples of cacao beans as ranging from 14 to 21 per cent., the average being 19 per cent. As this appears to be the usual moisture content of San Domingo cacao beans, this exceptionally high figure must be borne in mind in considering the various results of Ciferri's researches.

He examined a large number of samples of fermented and unfermented cacao beans (chiefly calabacillo) from stores in Sanchez, Samana and other places in San Domingo. He determined the number and distribution of the spores of mould fungi. He found on healthy fermented beans 950 spores per bean, and on healthy unfermented beans 3,050 spores per bean. The average numerical distribution of spores was as follows :

	Per cent.
Mucors	48
Aspergilli	39
Penicillia	10
Other moulds	3

He found the following species normally present: *Aspergillus niger, A. fumigatus, A. flavus, A. glaucus, Penicillium leucopus, Rhizopus nigricans, Mucor mucedo, Spicaria lateritia* and *Cephalosporium acremonium.*

Before leaving the subject of mould it may be well to summarise briefly a few points of practical value :

(1) Pod disease fungi do not cause the mould growth commonly found on commercial cacao beans.

(2) No mould is visible to the naked eye in a good fermentation. Visible mould can be prevented by one or more mixings during fermentation.

(3) Save actinomyces, which is very rare, the moulds which occur in unturned masses of cacao during fermentation (e.g. *A. fumigatus*) do not spoil the flavour of the cacao. They are objectionable chiefly because they open the way for internal moulding.

(4) The slight bloom of mould which develops during the drying operations, if kept under control and not allowed to penetrate to the interior of the bean, does not spoil the flavour of the cacao.

(5) The moulds which commonly develop in most countries on insufficiently dried cacao are *Aspergilli*, namely *A. flavus*, *A. tamarii*, *A. niger*, *A. glaucus*, *A. fumigatus* and *A. sydowi*.

(6) The controlling factor in internal moulding is that of water content, and typical moulds will not grow if the water content of the beans is below 8 per cent. [30].

(7) A store with an average daily relative humidity of over 82 per cent. is unsafe for the prolonged storage of cacao [30].

(8) Once cacao has been dried in the tropics, and is not wetted by sea water or sweat damage during transit, there is little danger of mould development in stores in England.

Do Fermented Beans mould more readily than Unfermented?

There is a distinct clash of opinion on this question between T. Laycock (Nigeria) and Ciferri (San Domingo). Laycock [26], as a result of careful work, states that fermented beans mould much more readily than unfermented. He is speaking of *external* moulding and finds the shells of fermented beans support the development of moulds more than the shells of unfermented. On the other hand, Ciferri found an average of 1,000 spores on the outside of each fermented bean as against 3,000 spores on each unfermented bean. He observed, too, that in an atmosphere of 79 per cent. relative humidity the unfermented became externally mouldy in ten days, whilst the fermented required sixteen days. As a result of a number of careful experiments he concludes that unfermented cacao is more susceptible to mould than fermented. The explanation of this divergence may lie in the degree of drying which the cacao had received prior to the experiments. Laycock's samples were probably originally dried to a normal figure of 6 to 8 per cent. of moisture, whilst Ciferri's beans appear to have been dried only to 14 to 21 per cent. of moisture, that is they were abnormally damp. As an indication of the degree of dampness it is worth noting that beans with

14 per cent. or more of moisture are, as Schwarz has shown, pliable in the shell.

The extensive experiments carried out on the Gold Coast by Bunting, Dade and Scott were made with a view to determining the conditions which result in *internal* moulding. The moisture present was of the same order as in Laycock's cacao, and Dade suggested that with unfermented beans (with whole shells) internal mould infection might be practically impossible. There is no doubt that these investigators consider that only the fermented bean is in any considerable danger of internal moulding.

It may be well to add the opinions of those who handle cacao beans commercially. It is generally accepted that unfermented cacao as it comes from the pod is higher in moisture and more difficult to dry than when fermented. It actually takes longer to dry and because of this the risk of *external* moulding is greater. It appeared to follow that the internal moulding would also generally be greater.

With regard to the cacao beans of commerce, the author held, with others, the opinion for many years that unfermented cacao was more liable to be *internally* mouldy. Yet Dade and Bunting are correct. The explanation is that in the places where fermentation is carefully followed, sufficient care is also taken in the process of drying so that no visible internal moulding is present in any of the beans. Hence well-fermented cacao is usually free from internal mould. Where fermentation is an accident or carelessly performed, the drying usually receives insufficient attention, with the result that bags of such cacao usually contain a percentage of internally mouldy beans as well as a percentage of entirely unfermented slaty beans. On examining closely the individual beans in bags of poor cacao of this kind, the author finds that the mouldy beans are usually not slaty but partly or completely fermented, and that the unfermented slaty beans are generally free from internal mould. The author's observations are thus in line with those of Dade and Bunting.

Causes of High Temperature

We have seen above that the growth in the pulp on the outside of the bean of certain yeasts, bacteria and moulds

with high optimum temperatures satisfactorily accounts for the high temperatures observed during fermentation. During the later stages (and during drying) changes take place in the interior of the bean and some of these (e.g. oxidation of the tannins) also contribute a certain amount of heat. These changes will be discussed later.

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(*To be continued*)

AN EVALUATION OF SOUTH AFRICAN GROWN *PINUS PATULA* PULPWOOD BY THE SULPHATE (KRAFT) PROCESS

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Introduction

As a result of an examination of the economic aspect of pulp and paper making in the Union of South Africa, it was decided to investigate the possibilities of the manufacture of wrapping paper from South African grown *Pinus patula*, Schl. and Cham., by means of an evaluation on a laboratory scale. The work was initiated at the Imperial Institute, London, while the experiments under review were conducted at the Forest Products Institute, Department of Agriculture and Forestry, Pretoria.

The wood was treated by the sulphate (Kraft) process, which involves incomplete digestion by chemical means and a subsequent grinding or refining treatment commonly effected in an edge-runner or " Kollergang."

The resulting paper, though dark in colour, is tougher and more pliable than that produced by the soda process.

Since the supply of *Pinus patula* for pulping purposes would be restricted mainly to the smaller sizes as yielded by thinning, the investigation was confined to material of 3 to 4 inches diameter. This represents the minimum size of pulpwood used commercially in other countries.

Raw Material

Being conveniently on hand, some *P. patula* poles from Jessievale Plantation, near Ermelo, Transvaal, were selected for the purpose of these tests. The trees were felled and barked in September 1934, and the pulping trials commenced at the beginning of November. The trees were nine years old, of the suppressed type removed in thinning operations. Diameter at breast height was 3 to

4 inches and the total height approximately 30 ft. Characteristic of the species, the wood was very light, having an oven-dry density of 20 lb. per cubic foot. The average width of the annual rings was 0·29 inch. The wood had a uniform very light cream colour, which darkened slightly on exposure. One thousand measurements of the fibre length were made and a rather abnormally wide range of

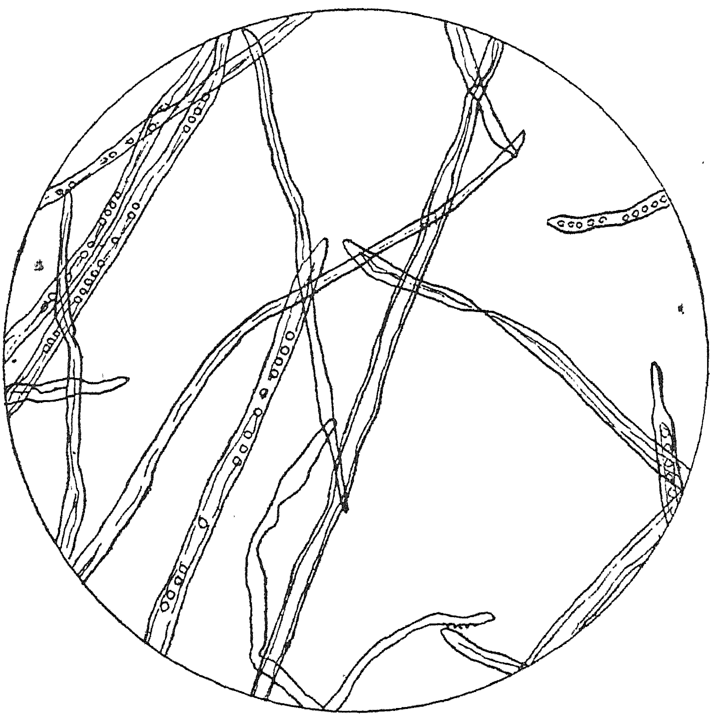

FIG. 1.—*PINUS PATULA* SULPHATE PULP × 64, FROM A MICROPHOTOGRAPH.

lengths was observed. The maximum length was 5·6 mm., minimum 1·0 mm. and average 2·6 mm. The average width of the elements was 0·04 mm.

It is noteworthy that the wood used in these tests was more slowly grown than that in the main *P. patula* areas of the eastern Transvaal, where the rainfall is heavier. While the rate of growth would have little effect on the chemical treatment necessary for the digestion of the wood,[1] considerable variation in the fibre dimensions is

[1] "The Evaluation of Second Growth Longleaf Pine Pulp Wood from Trees of varying Rate of Growth." Bray and Paul. *The Southern Lumberman*, December 15, 1930.

clearly illustrated by a comparison of the figures for the wood grown in different localities.

TABLE I.—COMPARISON BETWEEN FIBRE DIMENSIONS OF *P. PATULA* FROM DIFFERENT LOCALITIES

—	Locality.			
	Jessievale.	Graskop.[1]	Tweefontein.[1]	Spitzkop.[1]
Age of tree (years)	9	19	5½	8
Diameter of log (in.)	3–4	12	5½	5–6
Fibre length (mm.):				
Maximum	5·6	6·2	5·6	5·5
Minimum	1·0	1·9	1·5	1·7
Average	2·6	4·3	3·5	3·5
Fibre diameter (mm.):				
Maximum	0·069	0·0838	0·0762	0·0762
Minimum	0·019	0·0381	0·0228	0·0254
Average	0·039	0·0610	0·0457	0·0558

[1] *The figures in these columns were obtained from the Imperial Institute London, in a private communication.*

It will be observed from the table that the specimens under consideration had considerably shorter fibres than the wood of faster grown trees from farther east in the Transvaal. This fact should allow of an optimistic interpretation being placed on the results of the evaluation of the pulp obtained in the present investigation.

Pulping Experiments

The wood was reduced to chips approximately $\frac{3}{4} \times \frac{3}{8} \times \frac{1}{4}$ in. in size, by first cross-cutting the logs into $\frac{3}{4}$-in. discs and then chopping up the discs with a knife. The chips were tested for moisture content (which varied between 11·8 and 14·4 per cent.), the water contained in the wood being allowed for in making up the cooking liquor to the required concentration.

The pulping trials were carried out on a laboratory scale under conditions resembling as closely as possible those applied commercially in the sulphate (Kraft) process. The chemicals used consisted of a mixture of caustic soda and sodium sulphide in the proportion by weight of 70 to 30, the total weight of the chemicals being 20 per cent. of the oven-dry weight of the wood. In commercial practice sodium sulphide is not added as such. Losses of sodium in the recovery process are made good by the addition of

sodium sulphate which in the smelting chamber is reduced by the carbonaceous matter to sodium sulphide. The reaction is as follows :

$$Na_2SO_4 + 4\ C = Na_2S + 4\ CO$$

The sodium compounds recovered from the black liquor form sodium carbonate, which is causticised by means of milk of lime to form caustic soda. The cooking

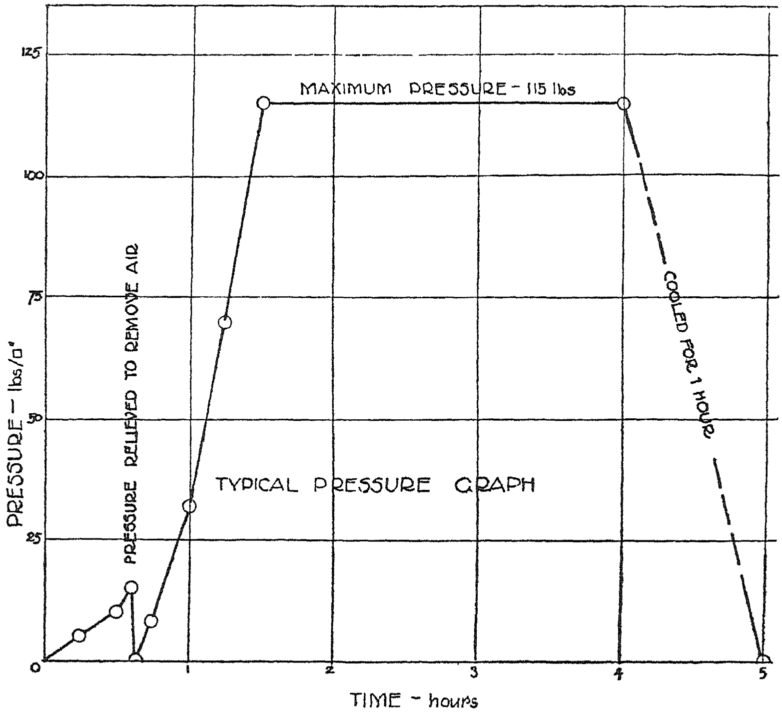

FIG. 2.

liquor at the end of the recovery process thus contains a mixture of caustic soda and sodium sulphide.

The digestions were carried out in a cylindrical iron autoclave of 5·6 litres capacity, fitted with pressure gauge, safety valve and relief valve. The digester was rotated about its long axis at the rate of 15 r.p.m. The maximum pressure employed during the present investigation was 115 lb., which would correspond with a temperature of 170° C. at the altitude at which the laboratory is situated. Maximum pressure was raised in 1½ hours, the relief valve being opened for a time after the first 30 minutes to allow

the air to escape. This operation involved the loss of a little steam and in some cases of a few drops of cooking liquor. A typical pressure curve is shown on the accompanying diagram (Fig. 2). The digester was allowed to cool for about an hour at the conclusion of each cook.

Table II shows the cooking conditions, chemical concentration and consumption, and yield of pulp for a series of ten cooks.

With the exception of the yield from cook No. 201, in each case the pulp was of attractive colour, appeared to be well digested and was readily disintegrated. As was to be expected, an increase in the time at maximum pressure resulted in a lower yield and a higher consumption of alkali, while an increase in concentration of the cooking liquor had a similar effect.

In every case investigated the yield may be regarded as distinctly favourable.

Though none of the cooks was designed to give an easy-bleaching pulp, a few of the yields were tested for their bleaching qualities. The fact that two of the cooks were reduced to a fair colour in one stage with 30 per cent. of bleaching powder (containing 35 per cent. available chlorine) suggests that an easy bleaching sulphate pulp should not be difficult to produce.

Evaluation of the Pulp

At the conclusion of the cook, the pulp was washed free from alkali, dried in a hand press, weighed and sampled for moisture content determination. The pulp was then beaten for various periods of time in a laboratory rod mill. The mill was of 13·2 litres capacity and was charged with ½-in. monel metal and ¾-in. stainless steel rods. It was rotated at 28 r.p.m. The ratio of the weight of rods to the weight of oven-dry pulp varied between 200 and 250 to 1, while in every case the pulp was beaten at 4 per cent. consistency.

Owing to a lack of standard apparatus for testing the tearing strength of the pulp, the evaluation was carried out on a comparative basis, Swedish first-grade Kraft pulp being used as control. It should be noted, however, that the pulps are not strictly comparable and the imported

TABLE II

Cook Number.	Cooking Conditions. Concentration gm/l. NaOH.	Na₂S.	Total.	Chemicals per 100 parts of oven-dry wood. NaOH.	Na₂S.	Total.	Maximum pressure.	Duration (hours). To maximum pressure.	At maximum pressure.	Black liquor ratio combined alkali to total alkali.	Yield.	Bleach added (one stage).	Remarks.
							(lb./sq. in.)			Per cent.	Per cent.	Per cent.	
201	28	12	40	14	6	20	100	$1\frac{1}{2}$	2	79·0	58·1	—	Pulp rather shivey.
202	28	12	40	14	6	20	115	$1\frac{1}{2}$	$2\frac{1}{4}$	85·2	51·0	—	—
203	28	12	40	14	6	20	115	$1\frac{3}{4}$	$2\frac{1}{4}$	82·7	57·0	—	Pressure gauge slightly adjusted for this cook.
204	26·3	11·2	37·5	14	6	20	115	$1\frac{1}{2}$	$2\frac{1}{4}$	80·4	58·6	—	—
205	28	12	40	14	6	20	115	$1\frac{1}{2}$	$2\frac{3}{4}$	76·3	56·0	—	—
206	28	12	40	14	6	20	115	$1\frac{1}{2}$	3	83·5	50·8	30	New pressure gauge fitted here. Pulp bleached to a poor colour.
207	42	18	60	14	6	20	115	$1\frac{1}{2}$	$2\frac{1}{2}$	78·3	48·8	30	Pulp very well digested. Bleached to a fair colour.
208	42	18	60	14	6	20	115	$1\frac{1}{2}$	2	80·0	51·5	30	Difficult to bleach.
209	56	24	80	14	6	20	115	$1\frac{1}{2}$	2	82·1	50·1	30	Bleached fairly readily.
210	56	24	80	14	6	20	115	$1\frac{1}{2}$	$1\frac{1}{2}$	74·4	57·3	—	—

pulp may only be accepted as a rough criterion. On the one hand, the imported pulp had, in the process of manufacture, been subjected to a process of refining by which it had been made tougher and more pliable, while, on the

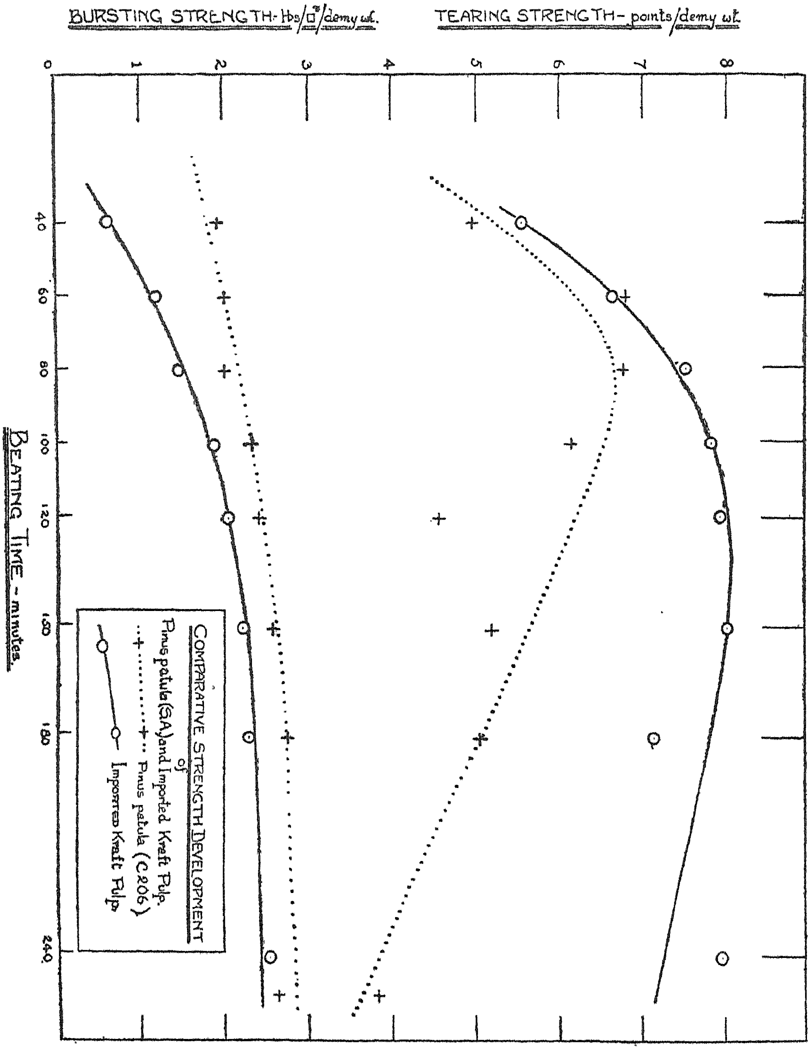

FIG. 3.

other hand, it had undergone rather drastic treatment on the drying rolls. In contrast to this the laboratory-made pulp was used straight from the digester, without any refining.

The standard Mullen tester (hand operated) was used for determination of the bursting strength. The tearing

strength was determined by the method suggested by Case.[1] Strips of paper 2½ in. by 1 in. are slit lengthwise for a distance of 2¼ in., leaving ¼ in. to be torn. The strip on one side of the slit is clamped to a stand, while to that on the other side is attached a flask to which water is added until the two strips are torn apart. The weight of flask plus water is taken as the tearing resistance. Figures for bursting strength are the average of 30 tests, and those for tearing strength, of 9 tests. For convenience of interpretation both bursting and tearing strength are expressed per demy (22½ × 17½ in. × 480 sheets) and per ream of 500 sheets, 24 × 36 in.

After treatment in the rod mill, the pulp was freed from coarse shives by washing through a screen of $\frac{3}{64}$-in. aperture. The test sheets (waterleaf) were made to a size of 9 × 7 in. on an improvised sheet form, pressed against a sheet of tin-plate, dried in an oven and conditioned before testing. The results of the strength tests are expressed in Tables III and IV and on the accompanying graph (Fig. 3).

TABLE III.—COMPARISON BETWEEN STRENGTH DEVELOPMENT OF *PINUS PATULA* PULP AND IMPORTED PULP

Beating Time (minutes).	Imported Pulp.				Cook No. 205.				Cook No. 206.			
	Bursting Strength.[1]		Tearing Strength.[2]		Bursting Strength.		Tearing Strength.		Bursting Strength.		Tearing Strength.	
	A	B	A	B	A	B	A	B	A	B	A	B
40	0·74	0·32	5·62	2·46	2·15	0·94	7·73	3·39	1·94	0·85	5·00	2·18
60	1·20	0·52	6·65	2·91	2·70	1·18	6·12	2·67	2·00	0·87	6·85	3·00
80	1·46	0·64	7·64	3·34	2·74	1·20	4·67	2·04	2·01	0·88	6·84	2·99
100	1·89	0·83	7·87	3·44	2·67	1·17	4·70	2·05	2·33	1·02	6·20	2·71
120	2·05	0·90	8·00	3·50	2·89	1·26	3·50	1·53	2·42	1·06	4·60	2·01
150	2·23	0·97	8·14	3·56	3·22	1·40	3·81	1·66	2·57	1·12	5·22	2·28
180	2·30	1·01	7·22	3·12	3·01	1·32	3·46	1·51	2·76	1·21	5·08	2·22
240	2·55	1·11	7·99	3·49	3·10	1·35	3·49	1·52	2·66[3]	1·16[3]	3·85[3]	1·68

A—*expressed per demy weight* (17½ × 22½ *in.* × 480 *sheets*).
B—*expressed per ream of* 24 × 36 *in.* × 500 *sheets.*

[1] *Expressed in lb. per sq. inch per unit weight.*
[2] *Expressed as tearing resistance (grams) per unit weight.*
[3] *Beaten for* 250 *minutes.*

It will be seen that, as regards bursting strength, the laboratory-made pulp is considerably superior to imported pulp. While the tearing strength shows a comparatively

[1] Case. *J. Ind. Eng. Chem.*, 1919, **11**, 49. Outlined in Sutermeister, *Chemistry of Pulp and Paper Making* (1920 edition), p. 409.

TABLE IV.—STRENGTH DEVELOPMENT OF PULP YIELD FROM COOKS 204 TO 210

Cook No.	Yield. *Per cent.*	Beating time. *mins.*	Demy weight. *lb.*	Burst/demy wt.[1]	Tear/demy wt.[1]
204	58·6	60	—	2·57	4·95
		120	—	2·92	3·71
		180	—	3·22	3·41
205	56·0	60	—	2·70	6·12
		120	—	2·89	3·50
		180	—	3·01	3·46
206	50·8	60	22·2	2·00	6·85
		120	18·9	2·42	4·60
		180	17·7	2·76	5·08
207	48·8	60	15·9	2·36	5·60
		120	16·6	2·61	4·40
		180	16·4	2·87	3·23
208	51·5	60	15·6	2·40	4·94
		120	14·1	2·65	6·46
		180	15·4	2·66	4·68
209	50·1	60	17·5	2·21	6·12
		120	17·2	2·48	4·42
		180	18·4	2·73	5·22
210	57·3	60	16·7	2·46	5·33
		120	14·5	2·58	3·80
		180	16·1	2·95	3·35

[1] *To express these figures per ream of* 500 × 24 × 36 *in., a factor of* 0·437 *should be applied.*

lower value, this is probably attributable to the absence of any refining action on the pulp. A general observation from the results of these tests is that, other things being equal, a longer period at maximum pressure yields a pulp with a lower burst but a higher tearing strength.

Summary and Conclusions

1. The wood of *Pinus patula* is very light in weight, is light in colour and possesses a good length of fibre.

2. Wood from small, immature, slow-grown, suppressed trees of this species was used in an investigation of its pulping qualities by the sulphate (Kraft) process.

3. A series of ten cooks on a laboratory scale were made. A yield of pulp of good appearance, varying in amount from 48·8 to 58·6 per cent. of the oven-dry weight of wood, was obtained.

4. The pulp had an excellent bursting strength ; but a rather low tearing strength, as compared with that of imported pulp, is ascribed to the absence of any grinding or refining treatment.

The results of this short investigation, which was subject to various limitations, together with those obtained at the Imperial Institute, are sufficiently promising to suggest, as far as one is willing to commit oneself from such small-scale experiments, that no difficulty would be experienced on a large scale in producing a high yield of pulp of good quality from South African grown *Pinus patula.*

EPHESTIA ELUTELLA AND *E. CAUTELLA* INFESTING CACAO

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A considerable amount of doubt seems to exist as to which species of moth is really the most prevalent in stored cacao. Much of this doubt has arisen owing to the likeness between the two species, *Ephestia elutella* Hübner and *Ephestia cautella* Walker. These two moths are externally practically the same. In good undamaged specimens the dark basal line on the cilia of the hind wings of *E. cautella* has sometimes been given as a specific character [1], but this feature tends to become less distinct on worn or damaged specimens and it is at best a very unsatisfactory character on which to divide the two species. Other quick methods have been suggested [2], but in actual practice they have not been found very simple to use.

A very complete and detailed survey of the *Ephestia* genus was made by Richards and Thomson [3] and they figure the genitalia of most species of this genus and of the *Plodia* genus. Their descriptions are based largely on microscopic preparations and this seems to be the only accurate method of separating the species. When the genitalia are mounted as microscopic preparations the

two species mentioned in this paper, i.e. *E. elutella* and *E. cautella*, can be easily identified.

In *E. elutella* the central portion of the male genitalia (a) is produced in a fairly narrow process while in *E. cautella* (b) it is blunt and rounded ; moreover, in *E. cautella*

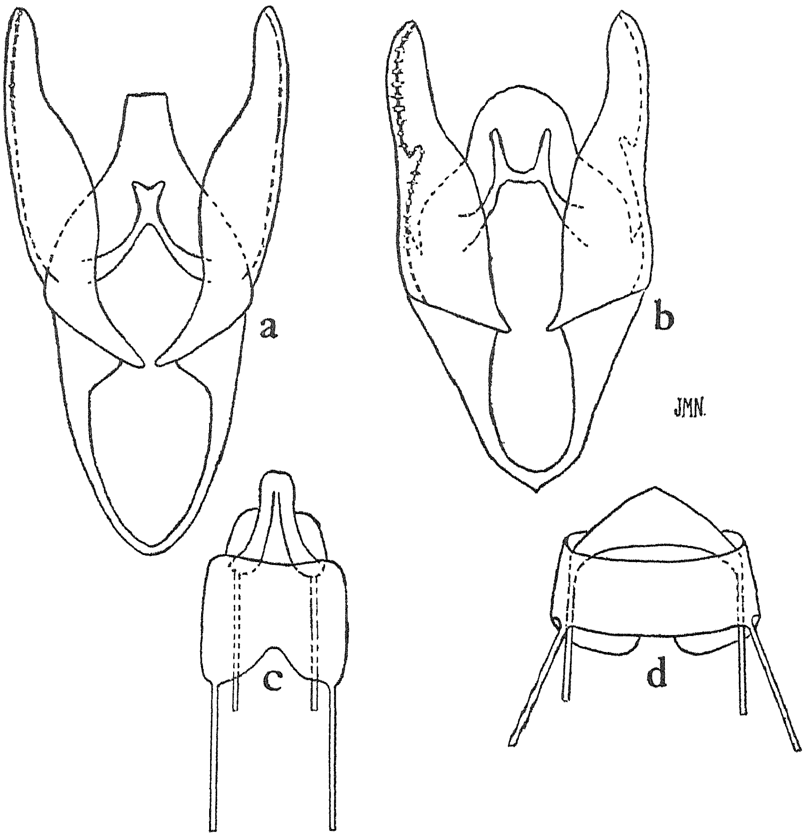

FIG. 1.

(a) *E. elutella*, Hüb., male genitalia. (b) *E. cautella*, Wlk., male genitalia. (c) *E. elutella*, Hüb., female eighth tergite and ovipositor. (d) *E. cautella*, Wlk., female eighth tergite and ovipositor.

there is a tooth on each clasper (the lateral wing-like processes). In the female of *E. elutella*, the ovipositor (c) is elongated, while in *E. cautella* (d) it is again blunt and rounded. Slight differences can be found in the wing venation, but these cannot be seen without the aid of a microscope and are not so definite as the characters in the genitalia.

It is doubtless because of this difficulty in separating

the two species that the rather haphazard nomenclature has arisen.

Usually any moth seen in the vicinity of cocoa is called *Ephestia elutella* on account of the popular name " Cacao moth " having been given to this species.

From the West Coast of Africa it has been found by a detailed examination of many moths that by far the most common moth imported in cacao from that country is *E. cautella*. Specimens of moths found over drying trays, collected by the Entomologist of the Nigerian Government, have been sent to the British Museum (Natural History), and all were identified as *E. cautella*. Cotterell in a recent Bulletin [4] describes this species as the moth which infests cacao on the Gold Coast and also in the stores and warehouses in Europe. A number of moths infesting cacao sent in sealed tins from Trinidad were found to be *E. cautella*. However, *E. elutella* seems to predominate in cacao from the West Indies and South America, but there now seems to be a definite admixture of both species throughout some of the cacao-producing countries.

In general it may at present be taken as a rough-and-ready rule that moths found on or near West African cacao will be *E. cautella* and that moths on West Indian cacao will be *E. elutella*. Owing to the transportation of moths from one country to another by ships carrying foodstuffs, the two species will undoubtedly become almost equally important as cacao-infesting insects.

Conclusions

1. *E. elutella* and *E. cautella* seem to be almost equally important as cacao-infesting moths.

2. Microscopic examination of the moths is the only sure way of separating the species, and for this the genitalia give the best characteristics.

3. Much doubt has arisen because of the likeness which exists between the two species, and a tendency has sprung up in this country to call any and every moth found on cacao, *E. elutella*. A more correct rule-of-thumb is that most moths from West Africa are *E. cautella* and most of those from the West Indies and South America are *E. elutella*. Although this is by no means an accurate

rule it is much more exact than the old method of classing all moths found on cacao under the name of *E. elutella.*

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NOTES

Chairmanship of Imperial Institute Advisory Councils on Mineral Resources and on Plant and Animal Products.—In view of the retirement of Sir Richard Redmayne, K.C.B., M.Inst.C.E., M.I.M.E., F.G.S., and Lt.-Col. Sir David Prain, C.M.G., C.I.E., F.R.S., on June 30, 1935, from the posts of Chairmen of the Imperial Institute Advisory Councils on Mineral Resources and Plant and Animal Products, respectively, a luncheon in their honour was organised by the Institute at the Hotel Victoria on Friday, July 12, 1935. Over one hundred ladies and gentlemen were present, including a large number of members of the Institute's Board of Governors, Advisory Councils and Technical Committees.

In the absence of Lt.-Col. John Colville, M.P., Chairman of the Board of Governors of the Imperial Institute, who had been called away on urgent political business, Sir Edward Crowe, K.C.M.G., Comptroller-General of the Department of Overseas Trade, took the chair. Lt.-Col. Colville, in a letter read by the Chairman, wrote:

"The Imperial Institute stands for a high ideal, that of assisting, and making better known, the economic products of the Empire. For this work it must rely largely on the services of scientific experts. Both Sir Richard Redmayne and Sir David Prain brought to their labours, as Chairmen of the two Advisory Councils which pass in review the technical work of the Institute under the respective categories of Mineral Resources and Plant and Animal Products, a wide experience, accurate knowledge and wise judgment. The field to be covered is very extensive, for there is scarcely a genus or a species of commodity which the

Empire cannot produce. The qualifications required of our Chairmen at the Institute are both extensive and profound, and we are more than grateful to Sir Richard and Sir David for the wonderful work which they have done for us in both fields. We wish them God-speed, long life and prosperity."

The Chairman welcomed Sir William Larke, K.B.E., and Mr. F. A. Stockdale, C.M.G., C.B.E., who are succeeding Sir Richard Redmayne and Sir David Prain, respectively, as Chairmen of the Institute's Advisory Councils.

Opening of Empire Film Library.—On Friday, June 14, 1935, His Royal Highness the Duke of Gloucester opened, at the Imperial Institute, the new Empire Film Library which has been organised in commemoration of His Majesty's Silver Jubilee. Lt.-Col. Colville, M.P., Chairman of the Board of Governors of the Institute, presented the address to His Royal Highness, to which His Royal Highness replied in suitable terms.

The Library contains films of Home production in industry and agriculture as well as the life and products of the overseas Empire. It is based on the Empire films originally included in the Empire Marketing Board Library which has been maintained on a temporary basis by the General Post Office ; and an arrangement has been made with the Post Office whereby their films will also be housed at the Imperial Institute. The films will be supplied to schools and other approved bodies in this country without other charge than the cost of their carriage to and from the Imperial Institute. A feature of the Library will be the large number of films made available to it by the Government of the Dominion of Canada, which has been the pioneer among Empire countries in recognising the vital importance of films to a fuller understanding of the present-day life of the Empire. At present the Library consists mainly of silent films, but the provision of " sound " films and the acquisition of " sound " apparatus is an important aim of the new venture and its realisation would greatly increase the efficiency both of the Empire Film Library and of the Imperial Institute Cinema. It is hoped that the Empire Film Library will thus become a centre for the collection of films which will reveal the life, scenery and industries of the overseas Empire to the general public and particularly to the rising generation of the British Isles.

Reception at the Imperial Institute.—Their Royal Highnesses the Duke and Duchess of York, attended by Rear-Admiral Sir Basil Brooke, K.C.V.O., and the Hon. Mrs.

Geoffrey Bowlby, were present at the Reception held at the Imperial Institute on July 4, 1935 (the forty-eighth anniversary of the laying of the foundation stone of the Institute by Queen Victoria) by the President of the Board of Governors and the Director of the Imperial Institute to welcome the Delegates from the Overseas Empire Legislatures to the Conference of the Empire Parliamentary Association.

The delegates were presented to Their Royal Highnesses by Sir Howard d'Égville, Organiser and Secretary of the Empire Parliamentary Association.

A large number of prominent United Kingdom and overseas Government officials, together with representatives of important industrial and commercial interests, accepted invitations to the Reception which undoubtedly afforded a useful opportunity for bringing to the notice of the delegates and their legislatures the work of the Institute.

***Strophanthus Emini* Seed from Tanganyika.**—Species of *Strophanthus*, a genus of the Apocynaceæ, are employed in medicine as a source of strophanthin, which is used as a tonic in cardiac affections. The source of official strophanthin is limited by the British Pharmacopœia to the seeds of one particular African species, *S. Kombé*. The United States Pharmacopœia also restricts the source of strophanthin to *S. Kombé*, but permits the use of seeds from *S. hispidus* in addition for the preparation of the tincture. The latter variety is official in the French Codex for the preparation both of strophanthin and of the tincture. In the German Pharmacopœia the seeds of *S. gratus* are alone official, and the strophanthin (crystalline g-strophanthin, ouabain) and tincture are derived from this source.

In 1927 an officer of the Tanganyika Department of Agriculture, visiting the Imperial Institute when on leave in England, was asked as to the possibility of obtaining Strophanthus seeds from Tanganyika Territory, and as a result, the Department forwarded in 1928 a sample of Strophanthus seed from the Tabora District for investigation. The seed was stated to have been determined at Kew as *Strophanthus Emini*, and this identification was confirmed by Kew after examination of the material received at the Imperial Institute.

Little information appeared to be on record regarding the constituents of this species of *Strophanthus*. J. Gordon Sharp (*Year Book of Pharmacy*, 1912, 281) had stated that a tincture prepared from the seeds exerted scarcely any toxic action on the frog's heart, but as long ago as 1901, Busse

(*Ber. Pharm. Ges.*, 1901, **10**, 418) had apparently considered the seeds to contain strophanthin, owing to their use as a source of arrow poison. A preliminary investigation of the seed from Tabora at the Imperial Institute indicated the presence of approximately 6·6 per cent. of crude strophanthin, as compared with a yield of 9·5 per cent. from *S. Kombé* seeds when extracted by the same method.

On account of this favourable result it was arranged with the Pharmaceutical Society of Great Britain that physiological tests should be carried out with the seeds in the Society's Pharmacological Laboratory. Subsequently three further samples of the seed from the Dodoma, Singida and Shinyanga Districts were forwarded to the Imperial Institute by the Department of Agriculture, and were similarly tested. The results obtained were as follows:

S. Emini, Sample No.	Source.	Activity in comparison with an average sample, *S. Kombé*. *Per cent.*
1	Tabora District	*
2	Dodoma District	85
3	Singida District	79
4	Shinyanga District	48

* *In this case a* 10 *per cent. tincture was found to exert an activity equivalent to a* 0·3 *per cent. solution of the official ouabain of the United States Pharmacopœia, whilst an average tincture made from the official 'Strophanthus Kombé' of the British Pharmacopœia is equivalent to a* 0·35 *per cent. solution of ouabain.*

In view of these results, the Imperial Institute approached the Pharmacopœia Commission in 1930 requesting that the possibility of including the seeds of *Strophanthus Emini* in the British Pharmacopœia might be considered, as being a product which might be found suitable for use in medicine as a source of the official tincture of strophanthus and of the glycosidal product, strophanthin. The Commission agreed to investigate the question, and two reports on the results obtained have now been issued in the *Quarterly Journal of Pharmacy and Pharmacology*, Vol. VIII, 1935, No. 1, pages 61–70 and 71–74, under the titles "The Strophanthin of *Strophanthus Emini*," by I. D. Lamb and S. Smith, and "The Seeds of *Strophanthus Emini*: A Report of Work Done for the British Pharmacopœia Commission." The following information is extracted from these reports.

The Commission were advised by a committee of pharmacologists that the seeds of *S. Emini* should be considered for inclusion in the Pharmacopœia only if it could be shown that tinctures made from these seeds are equivalent clinically to the tinctures made from *S. Kombé*, and that they offer no difficulties for biological assay.

The Commission accordingly arranged for investigations of the chemistry, pharmacognosy, pharmacology and therapeutics of the *S. Emini* seeds with a view to deciding whether the drug could be accepted as an alternative to *S. Kombé*. The varied and lengthy investigations required could not be completed in time for the results obtained to be considered in the preparation of the British Pharmacopœia, 1932.

The chemical tests by which the seeds of different species of *Strophanthus* may be distinguished from one another were investigated by Miss E. M. Smelt when Research Assistant to the Pharmacopœia Commission, and it was found that the seeds of *S. Emini* can be readily distinguished from those of other species by means of colour tests. The application of the following reagents to sections of the seeds, or to alcoholic extracts prepared from them, produces distinctive colours: (*a*) sulphuric acid, (*b*) phenol and hydrochloric acid, (*c*) furfuraldehyde, (*d*) resorcinol and hydrochloric acid.

Lamb and Smith extracted the strophanthin from the seeds and investigated its properties. The strophanthin obtained is a yellowish-white powder which resembles in characters and tests the present official k-strophanthin, from which it may be distinguished by the colour reactions mentioned above. It was found to be a complex mixture of water-soluble glycosides, similar in composition to, but not identical with, the official k-strophanthin. The water content, reaction to litmus, ash content, optical activity and other properties upon which a pharmacopœial description could be based, were determined.

The action of this mixture of glycosides on animals was found to show a cardiotonic activity equal to that of the British standard strophanthin.

The members of a Committee of the Pharmacopœia Commission have collaborated in investigating the question whether any difficulties would arise in the biological standardisation of *S. Emini*. A tincture was prepared, according to the Pharmacopœial directions, from the seeds supplied by the Imperial Institute. No difference in manipulation was necessary, and the official process was used without difficulty. The tincture was assayed by Professor J. H. Burn in the pharmacological laboratory of the Pharmaceutical Society of Great Britain, and was diluted in accordance with this assay so as to comply with the Pharmacopœial requirement of activity. Specimens of this standardised and adjusted tincture were examined in four biological laboratories, and the reports received are summarised by the Commission as follows :

"These reports show that when the frog method of assay is used the results obtained by workers in different laboratories are reasonably concordant. The result obtained by the use of rabbits as test animals, however, was lower than the others, and the suggestion was made that the pharmacological action of S. *Emini* may differ qualitatively from that of S. *Kombé*."

From a further investigation, made in a pharmacological laboratory at the request of the Commission, in order to discover whether any qualitative difference exists between the actions of the seeds of S. *Emini* and those of S. *Kombé*, it would appear that (*a*) in equal doses S. *Emini* takes a longer time than S. *Kombé* to cause systolic stoppage of the frog's heart, (*b*) that in the case of the isolated frog's heart S. *Emini* produces greater stimulation than S. *Kombé*, but that in other respects tinctures of both materials act similarly, and (*c*) that tinctures of both act in an identical manner on smooth muscle.

Clinical tests were carried out on behalf of the Commission by several physicians, who reported in all on eleven cases of heart ailments. In three of these cases it was stated that no ill effects were noted and that "it would appear from these few observations that the action of E-strophanthin is qualitatively and quantitatively indistinguishable from that of k-strophanthin," whilst in the eight other cases which were all of auricular fibrillation, the conclusion was reached that "E-strophanthin appears to be equal in its effects to k-strophanthin."

The results now accumulated thus indicate that the seeds of this species of *Strophanthus* are similar in their pharmacological action to those of S. *Kombé*, that the tincture made from them presents no difficulties in biological assay, and that the mixture of glycosidal principles obtained from them is similar in chemical composition and in therapeutic effects to the strophanthin obtained from the seeds of S. *Kombé*.

It is therefore hoped that the Pharmacopœia Commission may decide to recognise the seeds of *Strophanthus Emini* in the next edition of the British Pharmacopœia.

Chemistry of Weedkillers—Thiocyanates.—The following abstract of a paper bearing this title, by B. C. Aston, J. A. Bruce and J. B. Thompson, published in the *New Zealand Journal of Agriculture* (1935, **50**, No. 3, pp. 164–172), has been kindly furnished by the senior author.

The alarming spread of ragwort (*Senecio Jacobæa*) is a most serious problem facing New Zealand pastoralists. Many deaths and serious burning and explosion accidents

have resulted from the use of sodium chlorate for ragwort destruction during the past few years, and safer substitutes are being sought.

The purpose of these further experiments, conducted in the Hutt Valley near Wellington and at Rotorua, in the control of ragwort with commercial thiocyanates (also termed sulphocyanides and sulphocyanates) is part of a programme for testing out and developing a technique for the more promising groups of safer chemicals, namely thiocyanates, bisulphites, chromates and hypochlorites, which were selected from a list of over ninety different chemicals used in preliminary tests to ascertain their toxicity on ragwort.

Most of the experiments were conducted during November 1934, on ragwort in the rosette stage, on the Hutt Valley farm, where the infestation of the weed averaged from 15,000 to 30,000 plants per acre.

The importance of spraying equipment which will permit of economy in application of sprays to obtain proper coverage of ragwort is stressed. Even with otherwise efficient knapsack or hand sprayers, the nozzles fitted are not always capable of producing a fine spray and waste the solution. With large power sprayers, instances are recorded in New Zealand where ragwort coverage was effected with 50 gallons of weedkilling solution per acre and a complete kill was obtained, whereas with a knapsack sprayer over 400 gallons of the same solution per acre were required to obtain the same results. It will be seen, therefore, that with a power sprayer the cost of treatment per acre would be considerably lowered.

Tentative costs of the materials required in these trials using a hand sprayer were estimated on an acre basis at from £1 5*s*. to £5 for the more effective treatments, depending of course on the amount of material employed. Following is the result of the more effective treatments with ammonium thiocyanate on ragwort in the rosette stage of growth, which were confirmed by experiments conducted by a Country Officer stationed at Rotorua.

2½ per cent. solution at 200 gallons per acre gave an 80 per cent. kill.

5 per cent. solution at 200 gallons per acre gave an 80 per cent. kill.

10 per cent. solution at 200 gallons per acre gave a 100 per cent. kill.

5 per cent. solution at 400 gallons per acre gave a 90 per cent. kill.

Treatment of mature plants in the flowering stage

with a 10 per cent. solution at 200 gallons in one experiment was not very effective, and it would appear that thiocyanates are more effective on the rosette plants than on mature ragwort. Dry or moderately dry weather conditions also seem to favour their toxic action.

The crude liquor sodium thiocyanate in 7½ per cent. solutions at 200 and 400 gallons per acre gave kills of 60 per cent. and 80 per cent. respectively. Dry applications of ammonium thiocyanate mixed with superphosphate were made up in lots containing 10, 15 and 25 per cent. of thiocyanates and hand broadcasted at the rate of 4 cwts. per acre. The 10 per cent. mixture was ineffective and the other two gave kills of 75 and 90 per cent. respectively. The grass was greatly stimulated. Cutting and removing ragwort and applying ammonium thiocyanate mixtures was found to be ineffective.

Instead of striving for a 100 per cent. kill it would appear in some cases to be more economical to be satisfied with an 80 per cent. kill and deal with the surviving plants by re-treatment. Various mechanical devices on the market, usually consisting of metallic cylinders 4–5 ft. long for holding the weedkiller, were successfully tried during the course of the investigations. When the instrument is stamped on the crown of the weed the requisite amount of powder is released to kill the plant. This affords a simple, convenient method of dealing with scattered weeds.

Details of costs, directions for use and properties of the two types of thiocyanates used in the trials are given.

It should be noted that the costs of the materials quoted in the article are only of a tentative nature, as the price of ammonium thiocyanate would no doubt fall if a demand was set up.

It is noteworthy that cattle showed preference for areas treated with ammonium thiocyanate, which considerably stimulated the growth of grass some weeks after its toxic effects had worn off. Ammonium thiocyanate contains 37 per cent. of nitrogen and no doubt its ultimate stimulating effect on grass in the experiments was due to the nitrogen-residue it left in the soil.

Preliminary experiments indicate that this class of weedkiller has possibilities in horticultural practice, and in trials on gorse, blackberry and thistles the results were promising. Experiments are being continued in this direction.

Further articles during the course of the investigations will be devoted to bisulphites, chromates and hypochlorites.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Soils

Ceylon.—The following statement is made by Dr. A. W. R. Joachim, in his report on the work of the Chemical Division, Department of Agriculture, for 1934.

Early in the year an investigation was started in co-operation with the Forest Department on the relation between the vegetation and soils of the low country wet zone forests of Ceylon. Visits were made to seven typical *Hora* (*Dipterocarpus zeylanicus*) forests in the Southern and Western Provinces in the company of the Divisional Working Plans Officer. Samples of soil from typical 4-ft. depth profiles in each area were taken, and analyses of these made. Analysis of the silica : alumina ratio of the clay fractions revealed that the soils were all lateritic loams. They varied in texture from light to heavy clay loams, but the growth of *Hora* appeared to be best on soils which showed highest colloid moisture. Chemically the soils are extremely poor in replaceable bases and generally poor in phosphoric acid, but well supplied with nitrogen and humus in the first 18 in. They are all definitely acid in reaction. It was observed, however, that the percentage of stones and gravel and their disposition in the soil governed crop growth to a very marked extent; where these formed a compact mass preventing free root development, growth was poor. The investigation appears to indicate that the superficial examination of soil profiles of at least 4 ft. depth would give a good idea of the forest crop capabilities of the soil. The publication of the results of this investigation is to be taken in hand early.

Detailed studies were also made of profiles of the wet and dry patana soils, of the wet zone tropical red and yellow earths and of the cinnamon soil, and progress was made with a number of others, viz. the white and chocolate light sandy loams and the dry zone red and yellow earths. In addition to the field observational data, analytical determinations were made of the mechanical composition, reaction, organic matter, phosphoric acid and potash contents, and of the silica : sesquioxides (aluminium and iron oxides) ratio of the clay fraction. Three of the four soil types studied showed them to be lateritic soils, while the

wet patana soil type appears to be a laterite on the basis of its silica : alumina ratio. Rainfall is apparently the deciding factor. Most Ceylon red and yellow soils appear to be lateritic and a very few, it is considered, will be found to be typical laterites. The cinnamon soil appears to be a type of tropical podsol. One definite observation made is the close relationship between the nature of the rock material and that of the derived soil. The results of these studies are shortly to be published in a series of articles to *The Tropical Agriculturist.*

Manures

Ceylon.—Mr. W. C. Lester-Smith, in his report on the School Farm and Experiment Station, Peradeniya, for 1934, states that an area of nearly one acre has been brought into use as a compost area. Twenty-eight compost pits were employed in the making of compost during the year. These pits are modelled somewhat on the lines of the compost pits at the Indore Institute, being 2 ft. deep with sloping sides. The size of the base of the pits is 28 ft. long by 12 ft. wide, and that of the top or ground-level is 30 ft. by 14 ft. wide. They are not provided with cemented floors or sides. The pits are not roofed over or covered in any way; they are not at present connected up with any water supply, though the siting of the area was selected in part with this possibility in view, in the event of it being considered desirable at a later date. The total rainfall, and its distribution, in anything approximating a normal year, is considered to be adequate for the supply of a sufficient amount of moisture to the compost heaps for their proper decomposition and the production of a satisfactory type of compost within a period not exceeding three and a half months. During 1934 the continued dry weather made this impossible, with the result that in order to assist and accelerate decomposition, additional handling of the compost material was necessitated. In six of the pits the compost material was turned after a period of three months, as examination showed that the decomposition of the upper and outer layers was too slow. This adds to the cost of the completed compost, but it is necessary if all the material is not sufficiently decomposed by the end of a period of four months. The retention of open compost heaps of this type for a longer period than four months is illegal; it contravenes regulations made under the Plant Protection Ordinance (No. 10 of 1924), for preventing the breeding and spread of the Black Beetle (*Oryctes rhinoceros*) pest of the coconut palm.

In only one case up to date have any stages of this pest been recorded from the compost heaps, these being nearly full-grown larvæ which would still have had to pass through their pupal stage before emergence.

The work of compost making has been commenced with a view to ascertaining the best method of turning out, under conditions which could be normal to local cultivators, as large a quantity of humus as possible in a suitable condition for application to the land. A further aim which is also being kept in view is the greatest possible utilisation of all the waste material which becomes available in the cleaning of the land and in the harvesting or processing of the various crops. The materials which have been employed for this purpose up to the present, and those which have been available in largest quantity, have been weeds from the arable areas of the station which can be readily carted to the compost area. In this connection it is important to appreciate the fact that thorough and complete decomposition of those materials is a vital necessity in order that no living material in the form of roots or seeds be returned to the land in the finished compost. Additional sources of material for the making of compost have been Gliricidia loppings, Canna tops, coffee suckers and prunings, cattle bedding, wild sunflower, cacao shells and coffee pulpings. The cacao shells have proved to be somewhat resistant to decomposition, but this has been due in part to the fact that the dry weather made it impossible to maintain a sufficient degree of moisture in the heaps. Some very satisfactory compost has been made which in texture has been all that could be desired.

In his report on the work of the Chemical Division for 1934, Dr. A. W. R. Joachim states that several samples of compost manure, prepared by the Medical Department at Nawala and other centres in control of Medical Officers of Health, from night soil and street refuse and from street refuse alone were analysed for manurial value, and investigations made into the optimum conditions necessary for carrying out the process. In addition, a number of samples of compost prepared by the Indore process and by the pen method, and also in pits at various Departmental Experiment Stations were examined for comparison. The analyses indicate that pen manure is slightly superior in manurial value to compost made with street refuse and night soil, which in turn is of slightly higher manurial value than Indore and pit compost ; untreated refuse makes the poorest compost. The investigations

relating to the night soil and street refuse process reveal that : (1) there is no chemical advantage in retaining compost heaps under exposed conditions for longer than three months, (2) the analytical composition of the final product is dependent on that of the original refuse material, (3) the manurial value of the compost generally increases with the higher percentages of night soil added. A charge of about 15 per cent. is sufficient for a satisfactory breakdown. (4) A proportion of 1 of activator (decomposed compost) to 4 of refuse is sufficient to ensure satisfactory decomposition in a period of two months.

Since the publication of an article on the subject in *The Tropical Agriculturist* of November 1934, analyses were made of the lime contents of these composts, it being considered that these might be appreciable. Five samples showed respectively the following percentages of lime : 0·78, 0·93, 1·60, 1·69 and 2·72 with an average of 1·54 ; or 1·65, 1·81, 2·84, 2·86 and 4·32 with an average of 2·70 on air-dry material. An investigation is also in progress to determine the relative change in manurial value of a three-month-old compost sample by retaining it for a further period of two months under exposed and covered conditions.

Uganda.—The following reports on manurial experiments, carried out at the Serere Plantation and at Bukalasa, during the period July to December 1934, have been received from the Department of Agriculture.

At the Serere Plantation the effect on subsequent cropping of a single application of manure is being tested in a 5 × 5 Latin square, the five treatments being :

(*a*) Control.
(*b*) Lime.
(*c*) Farmyard manure at the rate of 10 tons per acre.
(*d*) ,, ,, ,, ,, ,, ,, 20 ,, ,, ,,
(*e*) ,, ,, ,, ,, ,, ,, 30 ,, ,, ,,

The manure was applied early in 1933 and the cropping since has been :

1933. Green manure, followed by Cotton.
1934. Millet (*Eleusine coracana*) followed by Cotton.

There were no significant differences in the yields of the first crop of cotton or in those of the millet, but there are indications that there will be a significant difference in favour of farmyard manure in the yield of the present crop of cotton.

A manurial experiment at Bukalasa on a cotton-ground-nut rotation was continued, the residual value of the manurial treatments being tested with the ground-nut crop.

The result showed a significant increase for "Cotton seed" alone which gave an increase of 723 lb. (unshelled) per acre over control and of 690 lb. over "Green manure."

At the Serere Plantation an attempt is being made to manufacture compost on the "Indore" system, using the grass *Imperata cylindrica*, of which there are large patches at Serere, and which is of no value for grazing, or as bedding for the cattle.

The amount of compost produced is limited by the water supply and a maximum of a ton of compost per day is made.

The process takes slightly longer than it does at Indore, but this is probably due to the use of a single grass instead of a mixture as advocated by Howard.

The resultant compost complies with the standard of fineness laid down by Howard.

A start has also been made at Bukalasa with utilising all the waste products of the plantation for the purpose of compost making. The early results have been distinctly promising.

Weeds

Water Hyacinth

Ceylon.—According to the report of Mr. F. P. Jepson, Controller of Plant Pests, for the year 1934, the increasing employment of sodium chlorate as a weedicide in many countries has suggested the possible use of this chemical against Water Hyacinth (*Eichornia crassipes*) in Ceylon. The first trials were conducted in 1931 under the direction of a representative of the Compagnie de Produits Chimiques et Electrométallurgiques, of Paris, who kindly provided a quantity of the chemical for experiment free of charge. The trials were carried out with the co-operation of the Divisional Agricultural Officer and Plant Pest Inspector, Southern Division. Two strengths of solution were tested, viz. 11 and $5\frac{1}{2}$ oz. of sodium chlorate in one gallon of water, applied at the rate of 968 and 484 gallons per acre, respectively. Although a marked scorching of the treated plants was observable two days after treatment, the plants in all treated plots were growing luxuriantly and in full bloom seven weeks later. The size of the treated plots was 180 sq. ft. in each case.

In 1932 these trials were repeated by the Plant Pest

Inspector, Southern Division, with plots of the same size but with increased dosages of sodium chlorate. Four strengths of solution were tested, viz. 9·7, 11·7, 13·7 and 15·6 lb., respectively, of sodium chlorate in one gallon of water, the rates of application in this case being $756\frac{3}{4}$, $907\frac{1}{2}$, $1,058\frac{3}{4}$ and 1,210 lb. of the salt per acre respectively. The maximum solubility of sodium chlorate is 9·4 lb. in one gallon of water if the salt is added a little at a time and the temperature of the solution is allowed to attain normal air temperature. It would appear, therefore, that the amounts of sodium chlorate employed in the above experiments were in excess of the quantities capable of being dissolved by the amount of water used and that, in each case, the strength of the solution used was the same, viz. a saturated solution, the amount of undissolved residue being proportionately greater as the dosages were increased. The salt was also applied in the dry state in one plot at the rate of 1,210 lb. per acre.

The effects of treatment were apparent in all cases within a period of twenty minutes, and all plants in the sprayed plots were stated to be dead seven weeks later. The effect of the dry application was less than in any of the sprayed areas, a result which is contrary to that obtained in later tests. Continued observations in the experimental areas were not possible, owing to the rapid encroachment upon them of the weed from the adjacent infested areas. Shortly afterwards, the entire area was cleared by hand by the officer responsible for its proper maintenance, and has since remained entirely free from weed. The experiment so far as it progressed indicated, therefore, that water hyacinth can be destroyed by the application of a saturated solution of sodium chlorate, but the possible reappearance of seedling growth in the treated areas could not be followed.

In 1933, a further supply of sodium chlorate was received from the manufacturers, free of charge, in order that further tests could be conducted by the writer, but it was not until February 1934 that weather conditions favoured the selection of a suitable site in which operators could move freely unhampered by an excessive depth of mud. The site selected was a densely infested area covered by 1 in. of water, the depth of mud being about 6 in. Four plots, each 2,500 sq. ft. in extent, were marked off. Two plots were sprayed with solutions of 8 and 4 lb., respectively, of sodium chlorate in one gallon of water, the spray being applied at the rate of 82 gallons per acre, equivalent to applications of 645 and $322\frac{1}{2}$ lb. of the salt per acre. One plot was also treated by broadcasting the

chemical in the dry state at the rate of 967 lb. per acre. Both spraying and broadcasting were carried out in fine weather. It was estimated that one man can spray an area of approximately one acre daily, using a pneumatic machine fitted with an extension rod and double nozzle, provided that the area is not too boggy and that the solution has been prepared for him and is readily accessible for the rapid refilling of the machine. In boggy land one-quarter of the above area, or less, is the maximum that could be sprayed in one day by one man.

In order that some comparison might be made between the respective merits of spraying with sodium chlorate and clearing by hand, one plot of the same size was hand-cleared, the plants being moved to, and stacked upon, dry land.

The effect of spraying with the stronger solution was apparent within a few minutes, the plants having a scorched appearance. The effect was not so marked in the plot treated with the weaker solution. The broadcast plot showed marked withering within a few minutes after treatment. A very noticeable effect of treatment in the three plots was the appearance, on the days following treatment, of a profusion of flowers. The plots were a mass of bloom and were in marked contrast to the vast surrounding untreated area where no flowers were visible. Two weeks later, quite 90 per cent. of the larger plants in the broadcast plot and that treated with the stronger solution were dead, the effects of scorching being rather more marked in the former plot. This observation was confirmed five days later, when a further 5 per cent. of large plants had died in the broadcast plot ; this percentage being increased by another 3 per cent. ten days later, leaving only 2 per cent. of larger plants still alive. Quite 10 per cent. of the best-developed plants had survived in the plot receiving the stronger solution, up to five weeks following treatment. The weaker solution was less effective, and although the main foliage had been scorched, the central leaves of the plants appeared to have escaped the action of the spray solution. After a period of five weeks not more than 10 per cent. of the plants had been completely destroyed. After the same period, minute and recently germinated seedling plants were making their appearance in the hand-cleared plot, which was otherwise clear and fit to be sown with paddy. The possible appearance of seedling growth in the treated areas could not be detected owing to the dense cover of rotted, or partly rotted, plants.

Later inspection of the sprayed areas indicated that

the treatment was not successful. The smaller plants which were protected from the spray by the foliage of the larger plants had taken entire possession of the treated areas, and the evidence of treatment rapidly disappeared, especially in the plot receiving the weaker solution. The broadcast plot, however, showed every evidence of the effect of the chlorate and there was little regrowth.

Repeated applications of spray at a very concentrated strength would no doubt eventually result in the complete destruction of all subsequent growth, but this result could only be achieved at a totally exorbitant cost when compared with that of hand-weeding.

The cost of a single spraying with 645 lb. of sodium chlorate per acre in solution, applied at the rate of 32 gallons per acre, according to the figures of cost of sodium chlorate available at present, is Rs. 160/–. The application of 967 lb. of the dry salt per acre, although apparently successful to date, has cost Rs. 240/– per acre. Even if all plants were destroyed, considerable preparation of the land would still be necessary before planting could be undertaken. On the other hand, the hand-cleared plot was freed of all plants and was fitted for immediate sowing at a cost of Rs. 17/25 per acre, even at the high wage of 75 cents per diem.

It would appear, therefore, that the hand-clearing method is every way more satisfactory so far as conditions in Ceylon are concerned. In certain countries where water hyacinth occurs, and where the daily rate of wages is quite twenty times that prevailing in Ceylon for similar work, the treatment of the weed by spraying with sodium chlorate might prove to be more economical than hand-weeding.

In Ceylon the cost of a single treatment with this chemical would, in many cases, far exceed the value of the type of land which is characteristic of the majority of the more serious infestations. In all infested areas, wherever a man can operate a spraying machine he can also remove the weed by hand. It is concluded that, in Ceylon, the treatment of water hyacinth by spraying with chlorate of soda cannot be compared with the removal of the weed by hand, either in cost, efficiency or in any other respect.

Dr. J. C. Haigh, Government Economic Botanist, reports that at the request of the Controller of Plant Pests work was started during 1934 on the conditions under which the water hyacinth is reproduced by seeds. Reports from other countries have indicated that seed may remain dormant for a long time, and suggest that a particular set

of conditions is necessary for its germination. These points are obviously of importance in the control of the pest, and consequently attempts are being made to determine the conditions under which the formation of seed and the development of seedlings take place in Ceylon. Seed has been produced by artificial pollination, but with some difficulty, and it is not yet known why some attempts have failed. Seeds have been induced to germinate, but again not with consistent success, and further work must be done before the conditions for germination are definitely understood. All attempts to grow the seedlings have hitherto failed. They develop to the stage of producing the first two leaves, and there they have stayed, either remaining in that condition or, more frequently, dying. Various media for growth have been tried, but without success. The work is being continued.

Contrasting the results reported above with the state of affairs in the field, where seedlings are reported as of common occurrence and where the presence of seedlings of all sizes indicates that the seedlings produced undergo normal development, it seems obvious that the climate of Peradeniya is unfavourable for the growth of water hyacinth, even under artificial conditions. This conclusion is supported by the growth of mature plants, which is very poor, and by the extreme difficulty experienced in persuading the plants to flower. This difficulty is indeed so great that the attempt has been abandoned, and when flowers are required they are obtained by having plants in bud sent from the Southern Province. In the circumstances, it is somewhat doubtful if the problem can be solved satisfactorily, but the only alternative is to transfer the experiments to the Southern Province, which is impracticable at present.

Insect Pests

Crickets

Ceylon.—According to the report by Mr. F. P. Jepson, Acting Entomologist, on the work of the Entomological Division, Department of Agriculture, for 1934, the lawn cricket (*Gymnogryllus humeralis*), during last year and the early part of the present year, caused very extensive injury to large grass areas such as golf courses, race tracks, garden lawns and other similar areas, in many parts of the island and particularly in the Colombo district. There was a cessation of activity during April, but it was resumed in May and June, since when, however, the insects have caused less trouble.

The fact that the insects do not thrive in captivity has proved a handicap to the study of their development and habits, and a scarcity of the insects, due, no doubt, to the unusual drought, has made it difficult to secure material for the required observations. Mr. E. de Alwis was able, however, to carry one pair of the insects through their development from the egg stage. The eggs, which are deposited in the burrows in the soil, hatched in fourteen days. Only two nymphs obtained from eggs survived and reached the adult stage, fortunately one of each sex. The female attained the adult state in six months and eighteen days, and lived for a further forty days in captivity but failed to lay eggs. The male became adult in the same period and lived for thirty days. Further attempts will be made to obtain information on the points required, particularly with regard to the number of generations normally raised in one year and the seasons of egg-laying.

Experiments in spraying the affected grass areas with arsenate of lead, at a strength of 1 oz. to 2 gallons of water, resulted in a cessation of some cast formation. Certain non-arsenicals, when used at a strength sufficient to kill the insects, caused a scorching of the grass, and their use was not persevered with.

Considerable success, following an application of " mowrah " meal to the affected areas prior to rain or liberal watering, is reported from some areas where this treatment has been tried, but there was no opportunity of verifying these reports.

Termites

Ceylon.—The report of Mr. F. P. Jepson, Assistant Entomologist and Controller of Plant Pests, for 1934, contains the following statement on the work carried out on termites during the year.

Bionomics of Tea Termites.—The study of the life-cycles of *Neotermes militaris* and *Glyptotermes dilatatus*, both serious pests of tea bushes, has been continued. Reference has been made in the annual reports of the past seven years to the progress of two colonies of *Neotermes militaris* raised from eggs laid by pairs of winged adults over seven and a half years ago. In one of these colonies winged adults were produced during the latter part of the year, but in the second colony winged adults have not yet appeared. So far as is known, a species of *Neotermes* has not previously been carried through its entire life cycles from eggs to the winged reproductive form by any other worker.

The colony of *Glyptotermes dilatatus*, referred to in earlier reports and which was raised from eggs laid by

apterous adults, nearly seven years ago, is still thriving and produces winged forms at intervals.

Bionomics of Dry-wood-nesting Termites.—The colonies of dry-wood-nesting termites, referred to in last year's report, are being maintained. During the period covered by the present report winged reproductive adults were obtained from a colony of *Cryptotermes perforans* founded nearly five years ago by a winged pair.

A result of considerable academic interest which has been obtained during the year was the production of winged reproductive adults in a colony of *Cryptotermes perforans* raised as a result of crossing a winged male with a neoteinic (wingless) female of this species. No similar result appears to be on record. The winged adults were produced in this colony in a period of four years and ten months.

A colony of *Planocryptotermes primus*, raised from a winged pair, produced winged adults during the year, the complete cycle occupying five years and eight months. The colony is still flourishing. Another colony of the same species, raised from eggs laid by winged adults over six years ago, gave rise to winged forms during the year. In a third colony, raised from winged adults and which is now three years and nine months old, a few nymphs with long wing pads are present. On a previous occasion, as was mentioned in the report for last year, a colony of the same species, raised in the same manner, produced winged forms in a little under four years and eleven months.

In a colony of *Planocryptotermes primus* raised from neoteinic adults, winged adults were produced after nearly six years. In another experiment, commenced a little over six years ago, with neoteinic adults, and in which the development of the colony was not very satisfactory at first, a few nymphs with short wing pads and some with long wing pads are present. The number of members of this colony is small.

Sprue and "Dry-rot."—Much interest, both in Ceylon and abroad, has been shown in the hypothesis advanced by the writer that sprue may be due to infection following contamination of human food by the excreta of dry-wood termites. The hypothesis is being examined by Dr. L. F. Hirst, a former Microbiologist to the Colombo Municipality.

Interest in this subject has added considerably to the work of the writer, and requests to examine bungalows in which cases of sprue have arisen have been numerous. They have not been acceded to, in all cases, owing to pressure of other duties. Hitherto, attention has been focused, mainly, upon the infestation by dry-wood ter-

mites of the buildings themselves, but a case of considerable interest was met with during the year in which the bungalow itself was unattacked but the three safes in which the food was stored were riddled by the insects. The object of inspecting the bungalow in which these safes were found was on account of the two occupants, very old residents in the island, having developed sprue almost simultaneously. They were obliged to undergo treatment in England. The shelves of the safes were littered with the fæcal pellets of the insects and 150 c.c. of this solid excrement were shaken from a small piece of shelving from one safe situated above a pen in which milk was allowed to set. There is no doubt that much of the food consumed by the occupants of this bungalow has been contaminated by the droppings of these insects for several years.

Specimens of the living insects were handed to Dr. L. F. Hirst, for a bacteriological examination of the intestinal contents, and it is believed that the material has yielded information of interest and of possible importance in connection with this enquiry.

Further reference to this subject will be found later in this report under the sub-heading "damage to buildings by termites."

Control of Termites affecting Plants.—The treatment of *Neotermes militaris* by the Paris Green method, although temporarily abandoned on some estates for reasons of economy, is still widely used in the infested regions. The pressing need for the production of a microphone for the detection of infested tea bushes has been stressed by one correspondent who has now employed this method of treatment for the past six years. On this estate 18,000 bushes, distributed in 307 acres, were treated by this method during 1933. The Superintendent wrote as follows: "The treatment continues to give satisfactory results in the bushes actually treated and there appears to be no doubt that many bushes, representing quite a large area of tea, are being saved which without treatment would have perished." He points out, however, that many infested bushes escape treatment owing to the absence of visible manifestation of infestation and that treatment can only be regarded as being partially effective if a large percentage of infested bushes escape treatment. This fact has long been recognised, and as a result of the continued interest in our problems on the part of Dr. T. E. Snyder, of the U.S. Department of Agriculture, continuous investigations have been in progress in America since 1928 to discover a suitable microphone for field use.

Somewhat elaborate instruments, suitable for laboratory use, have been designed, but they were quite unsuitable for the rough usage which they would be required to undergo on a tea estate.

The need of an instrument for the detection of insect infestation by sound transmission is felt in many branches of economic entomology and the matter is now engaging the attention of the Department of Scientific and Industrial Research in England.

Although the Paris Green treatment of tea bushes infested by *N. militaris* is now a general routine practice on certain estates, the necessity for the treatment of interplanted *Albizzia*, heavily attacked by the same species, has become evident on one estate in the Maskeliya District. The wisdom of interplanting trees which require to be periodically lopped, for green manure or other purposes, on tea estates which are infested with tea termites, has been questioned in previous reports. Unless the lopping is very carefully done the snags are certain, in time, to provide suitable sites for the winged stages of termites to effect entry and become established. There is no doubt that, on some estates, old *Albizzia* and *Grevillea* trees have become breeding-grounds from which enormous numbers of these insects escape to the surrounding tea. If trees are required for shade purposes, it is suggested that they should be allowed to perform their intended function undisturbed. The establishment of trees which are intended to serve the dual purpose of providing shade and green material for manurial requirements is a policy which does not commend itself for adoption on termite-infested estates, and green manure requirements should be supplied by plants having a less woody habit of growth.

The destruction of the termites in old trees, and the eventual removal of the trees themselves, are matters which are now causing concern on certain estates in the termite-infested areas. The extensive root systems of *Albizzia* trees have been found to harbour *N. militaris* in very large numbers, and such trees must prove a menace to the tea bushes with which they are interplanted. The experimental destruction of old trees by poisoning methods was tried on one estate in Maskeliya during the year, but with little success.

Advice was sought regarding the treatment of *Neotermes militaris* and *Glyptotermes dilatatus* on an estate at Deniyaya where these two species occurred in the same field. This is not usual, the former being active at higher, and the latter at lower, elevations in the island. This estate was inspected and the immediate adoption of the Paris Green

treatment was advocated. Another tea estate, near Akuressa, was also visited on the same occasion in connection with a fairly extensive attack by *Glyptotermes dilatatus*. In this instance the Paris Green treatment had been employed for some time, but the suggestion had been made that some injury to the bushes had followed treatment. It was found that, in all cases where signs of injury were apparent at the point of injection, the bushes had not been attacked by termites, holes having been drilled, and Paris Green injected, into sound wood. Similar injury has been observed before, and is due to the small amount of soluble arsenic which Paris Green contains having entered the sap-conducting vessels. It is important that only those bushes which display definite evidence of attack should receive treatment. Further advice for the treatment of *N. militaris* was given in the case of an estate in Maskeliya where the Paris Green treatment has been employed for some time and suggestions for dealing with the same pest in *Albizzia* trees were also given.

N. greeni caused injury to *Grevillea* at estates near Matale and Peradeniya, and advice on treatment was given.

Tests of Building Materials.—A sample of timber treated with a rubber distillate solution, furnished by the Rubber Research Scheme of Ceylon for trial, has now been under test in an active nest of *Cyclotermes redemanni* for seventeen months without suffering injury. In some months, owing to the exceptionally dry weather, there has been little activity near the soil surface in the nests of subterranean species of termites. The fact that a similar piece of timber, treated in the same manner and exposed to the attacks of the same species of termite, was completely destroyed in five months, suggests that the test with the second sample is not very conclusive.

Two samples of ceiling and insulating fabrics of British manufacture have been under test against injury by *Cyclotermes redemanni* and *Hypotermes obscuriceps*. Although the samples remained unattacked, the tests had to be discontinued owing to the absorption by the samples of moisture from the soil and their consequent disintegration.

A test was started on behalf of the Public Works Department to ascertain the immunity, or otherwise, to termite injury of a sample of pinewood timber impregnated with a proprietary preparation alleged to possess termite-repelling properties. The sample was placed in the active nest of *Cyclotermes redemanni* on July 20, and it remained unattacked till December 18, when termite injury was

observed to have commenced. Whether the damage will be extended remains to be seen.

At the request of the Public Works Department tests with two paint mixtures, reputed to possess termite-repelling qualities, were commenced during the latter part of the year. At the time of writing no injury has been caused by termites to the treated samples of wood which are under test.

At the request of a Colombo engineering firm two grades of a new insulating wallboard fabric, treated and untreated, respectively, have been tested against soil and dry-wood-nesting termites, during the latter part of the year. Damage to the untreated grade by *Hypotermes obscuriceps* was rapid and the whole sample was completely destroyed within two months, while the treated grade remained unattacked during this period. A small test with *Planocryptotermes primus* also shows that these insects cannot live when fed on the treated material, while they can do so in the case of the untreated grade.

Several requests have been received for information which has been based on earlier trials with various timbers and ceiling materials.

The growing popularity of ceiling boards, made from plant fibres or exploded wood, is indicated by the large number of such products now on the market. They are superior to local ceiling boards as they are more readily fixed in position, have valuable insulating properties, some have been treated with termite-resistant dressings, and they do not warp as unseasoned ceiling boards invariably do in this country. The possibility of considering the manufacture of similar ceiling boards from waste coconut fibre, possibly mixed with some form of rubber, has been brought to the notice of the Coconut and Rubber Research Schemes and samples of the types of boards now on the market have been submitted to the officers of these institutions. This possibility is deserving of consideration, and if a suitable board can be devised the treatment of the materials used in manufacture with a termite-repelling substance should present no serious difficulty. As waste fibre may be procured in many parts of Ceylon for the cost of its transport, the price of boards manufactured from waste fibre should compare favourably with that of imported insulating boards. If the manufacture of such boards is found to be possible in Ceylon there should be a wide demand for them locally and, possibly, also in other countries.

Damage to Buildings by Termites.—Very extensive damage to the timber of the ground, first and second

floors of a tea factory by *Coptotermes ceylonicus*, in the Yatiyantota District, engaged some attention. The damage is of long standing, and in the past attention has been directed merely to the replacement of the damaged timber when it was no longer serviceable. Advice was sought as to whether the trouble could be permanently terminated and, as a result of personal inspections, the entry of the insects was traced to the external dwarf walls, particularly where these adjoined the stone-work columns.

Another tea factory in Kahawatte was also extensively damaged by *Coptotermes ceylonicus*. This place was also visited and suitable advice given.

The tea factories of three estates situated at Gampola, Kahawatte and Dehiowita, respectively, were also visited in order to advise on the steps to be taken to deal with extensive invasion of the buildings by *Coptotermes ceylonicus*.

Some damage has been caused to the new wing of the Colombo Museum, which was completed about four years ago, by the same species of termite. Several days were occupied in an attempt to trace the entrance points of this species, but so far without success. Another subterranean species which had invaded the Museum building was *Termes ceylonicus*. The entrance places of these insects were found and remedial measures suggested.

The Office Assistant's bungalow at Jaffna, the Police Court building at Chavakachcheri and the Police Magistrate's bungalow at Gampola, were attacked by *Coptotermes ceylonicus*. The same insect also caused injury to bungalow woodwork in an estate near Panwila.

Damage was also caused to estate buildings by *Termes horni* at Rangalla, Opanaike and Kahawatte and by *Cyclotermes redemanni* at Matale. Both of these species are subterranean in habit.

Samples of timber damaged by unknown species of soil-nesting termites were also received from various other centres.

Several bungalows have been examined in connection with termite injury and suitable advice was given for arresting further trouble.

As a result of continued cases of illness in a Government bungalow, in Kandy, attributed by the occupants to so-called " dry-rot," a special examination of this building was made and a report submitted to the Provincial Engineer, Central Province, North. This building was examined some years ago in consequence of the development of sprue by a previous occupant and the entire roof-

frame work was found to be infested by *Planocryptotermes primus*, a species of dry-wood-nesting termite.

Two buildings occupied by officers of the Department of Agriculture at Peradeniya were examined on account of a history of intestinal ailments on the part of the present, or past, occupiers. They were both found to be extensively attacked by *Planocryptotermes primus*.

Specimens of timber from a Government bungalow in Jaffna yielded the pellets of a species of *Cryptotermes* in abundance. A request for these specimens followed the information that a recent occupant had contracted sprue.

The examination of an estate bungalow in Madulsima was made at the request of the occupant, whose illness had been diagnosed as sprue. The roof of the kitchen was riddled by dry-wood termites, their excreta being found on all articles of furniture in this room as well as in the food safe, into which they had fallen from an infested beam to which the safe was suspended.

An estate bungalow, near Haputale, in which three successive cases of sprue had developed within the past few years, was found to be heavily infested by dry-wood termites.

Another estate bungalow, at Lunugala, was inspected at the request of the Superintendent, who had developed sprue in the building. His wife had also suffered from sprue for some years, and a previous occupant, after an illness extending over five years, eventually succumbed to the disease. There was evidence of attack by dry-wood termites throughout the building in spite of extensive repairs having been effected in recent years.

The widespread infestation of a bank building in Kandy by dry-wood termites, particularly in the kitchen, led to the abandonment of the living quarters by the Manager following an inspection of the building conducted at his request.

Various samples of timber attacked by dry-wood-nesting termites or of the fæcal pellets of these insects were received for report from various parts of the island, as well as timber attacked by weevils, Bostrychid beetles and fungus rots.

Mound-building Termites.—Many nests of mound-building termites, *Cyclotermes redemanni* and *Hypotermes obscuriceps*, have been successfully treated with petrol. The Royal Botanic Gardens, Peradeniya, which at one time contained a large number of these mounds, are now free, new nests being treated as they are detected. The same remarks apply to the Heneratgoda Botanic Gardens and certain experiment stations. Some thousands of

nests in areas under the administration of the Department of Agriculture have now been treated and the efficacy of the method is well proved. The dosage of petrol required for each nest can be calculated upon the basis of 1 oz. of petrol for each 6 in. of diameter measurement of the base of the mound. The mounds should first be levelled and one hole, about 12–15 in. deep, drilled according to the above calculation in the area previously covered by the mound, the holes being evenly distributed over the site and stamped down after the injection into each of 1 oz. of petrol. The method is simple and economical. Mound formation is particularly active preceding the monsoon seasons, and treatment at these periods will result in the destruction of large numbers of winged reproductive forms awaiting a suitable opportunity to emerge and form new colonies.

Frequent inspections of the Royal Botanic Gardens, Peradeniya, have been made for the purpose of detecting the formation of termite mounds. A number of nests formed by these insects in the grounds of the headquarters of the Department of Agriculture, Peradeniya, have been treated.

Insecticides

Derris

Ceylon.—The report of Mr. W. C. Lester-James on the School Farm and Experiment Station, Peradeniya, for 1934, contains the following account of work carried out on species of Derris.

Planting material of *Derris elliptica* and *Derris malaccensis* were imported from Sarawak for experimental purposes in 1928. These were planted early in October of that year in a section of the fruit plots being used as a nursery, for purposes of multiplication. In 1931 cuttings from both of these species were planted out for trial purposes under the shade of old rubber, but the growth of neither was sufficiently encouraging to warrant any extension, and it became obvious that there would be considerable difficulty and expense in the harvesting of the roots. By 1932 sufficient material was available for planting out a small area of each species on well-prepared arable land without shade. This was done; two quarter-acre plots (A 4 and B 4) in the then annual economic area were planted on May 26, 1932, with cuttings of *Derris malaccensis*, and a quarter-acre plot (20 C) in the same area was planted on June 16, 1932, with cuttings of *Derris elliptica*. Harvestings, of one or more complete rows of plants, were made from these areas at different periods in their growth.

After the growth periods indicated below, the tops were first cut away and the roots harvested, cleaned, sun or shade dried as weather permitted, cut into short lengths for convenience in handling and further drying, and sent to the Agricultural Chemist for analysis.

The records of the two species, including certain figures from Dr. A. W. R. Joachim's report on the work of the Chemical Division, are given hereunder:

Derris malaccensis

(The erect-growing species)

Harvesting number	1	2	3	4
Growth periods in months	14½	19½	22¾	27
Number of plants harvested	237	612	447	35
Wet weight of roots per plant in pounds	0·07	not recorded	0·04	1·57
Dry weight of roots per plant in pounds	0·03	0·05	0·16	0·37
Percentage dry weight to wet weight	42·8	—	40·0	26·6
Dry weight of roots in pounds per acre (calculated)	130	257	774	1,798
Percentage moisture	11·50	12·05	12·22	9·09
Percentage mean ether extract on moisture-free basis	20·74	20·90	18·00	25·92
Total ether extract in pounds per acre	23·9	47·2	122·3	423·8

In the case of the first harvesting the roots were shade dried indoors throughout the drying period owing to the weather being unsuitable for sun drying. In the remaining three harvestings the roots were first sun dried and subsequently shade dried; and, in the case of the third harvesting, the roots were attacked by wood-boring beetles.

Derris elliptica

(The ground-creeping species)

Harvesting number	1	2	3	4	5
Growth periods in months	16	21½	22	24¾	28
Number of plants harvested	251	246	100	440	129
Wet weight of roots per plant in pounds	not recorded	0·33	0·30	0·39	0·89
Dry weight of roots per plant in pounds	0·03	0·19	0·17	0·22	0·36
Percentage dry weight to wet weight	—	57·6	56·7	56·4	40·4
Dry weight of roots in pounds per acre (calculated)	135	925	823	1,078	1,742
Percentage moisture	10·54	—	13·32	13·42	12·69
Percentage mean ether extract on moisture-free basis	15·42	15·0	15·0	8·55	5·98
Total ether extract in pounds per acre	12·0	—	113·7	79·8	90·9

In the case of the first harvesting the roots were shade dried indoors, the other harvestings being first sun dried and then shade dried. In the case of the roots of the second and third harvestings both lots were slightly attacked by wood-boring beetles.

Further plantings of both species of *Derris* have been made during the year and the area under each is being extended with a view to further experimental work both as regards selection and analysis. Root and stem material of both these introduced and of other indigenous species of *Derris* collected by the Economic Botanist were sent to England for investigation and report, but no details of these are to hand as yet. A few plants of *Derris thyrsiflora* which were obtained from Singapore in 1929 are being maintained, but their growth has been extremely slow. Their multiplication by means of hard wood cuttings has been effected, but they have not rooted readily or rapidly.

Pyrethrum

Ceylon.—Dr. J. C. Haigh, in his report on the Division of Economic Botany for 1934, states that it is yet too early to be definite, but there are indications that the growing of pyrethrum may become a commercial proposition in the Bandarawela district. Out of the plants originally raised, 60 per cent. are still alive, in spite of an abnormally wet season followed by an abnormally dry one. Only ten out of more than 200 plants have flowered, but those flowers appear to have set seed which is now being tested and, if good, should produce an acclimatised strain. The plants raised at Peradeniya have now been growing for nearly two years; but have shown no signs of flowering. The field officers to whom seeds were sent failed to raise plants.

Beverages

Tea

Ceylon.—Mr. F. P. Jepson, Acting Entomologist, in a report on the work of the Division of Entomology, Department of Agriculture, for 1934, states that the scale insect *Saissetia coffeæ* (*hemisphærica*) infested five acres of tea on an estate situated at 7,000 ft. in the Nuwara Eliya district. This pest is often troublesome in drought periods, but is usually rapidly controlled by the parasitic fungus, *Cephalosporium lecanii*, with the onset of the monsoon rains. *Coccus viridis*, another scale pest which is naturally controlled by the same fungus, was reported from two estates near Hakgala and Gampola, respectively. It is a serious pest in the Haputale district at certain seasons of the year.

The nettle grubs, *Thosea recta* and *T. cervina*, were reported from the Ratnapura and Dimbula districts, respectively, and the fringed nettle grub (*Natada nararia*) from an estate near Kandy. These records are unusual.

Nettle grubs are particularly prevalent in Uva, in which province they are declared pests. Among the other records received were the red slug (*Heterusia cingala*) from estates in Dimbula and Galaha; the red borer (*Zeuzera coffeæ*) from Kotmale and Haldumulla; red spider (*Tetranychus bioculatus*) from three estates in the Kandy, Matale and Gammaduwa districts, respectively; aphids (*Toxoptera aurantii*) on seedlings from Yatiyantota and from an estate near Madulkelle; the small tussock (*Notolophus posticus*) from estates near Kandy, Maskeliya and Madulkelle; *Dasychira thwaitesi* from Maskeliya and *Prodenia litura* from Madulkelle.

A record of particular interest was the injury to tea seed in nursery beds on an estate at Maskeliya by the Ortalid fly (*Adrama austeni*) which behaves in a similar way to the tea-seed fly of Java (*Adrama determinata*). Only cracked or germinated seed is attacked, but the fly can be prevented from ovipositing in the seeds by covering them with a thin layer of soil. Only one previous instance of this type of injury has been recorded in Ceylon.

Another enquiry of interest was in connection with the infestation of consignments of Ceylon tea on arrival in Canada with *Psocidæ*, commonly termed Book Lice. Attempts to discover the source of infestation have, so far, failed. Inspection of go-downs and barges in Colombo resulted in no specimens of these insects being discovered. The possibility of infestation occurring during transit from other articles of cargo is one which the shipping company concerned refuses to recognise. No previous instance of an infestation of this nature appears to be on record.

CEREALS

Millet

Uganda.—At the Serere Plantation, during the period July to December 1934, a millet transplanting trial was carried out for observation purposes so that information could be obtained for the designing of a transplanting experiment. It consisted of eight plots, one for each of the following treatments:

Ordinary broadcasting of seed.
Germinated seed broadcast.
2-in. seedlings planted out at 6 × 6 in.
" " " " " 9 × 9 "
4- " " " " " 6 × 6 "
" " " " " 9 × 9 "
6- " " " " " 6 × 6 "
" " " " " 9 × 9 "

Observations showed that there had been a tendency to select forward seedlings for the " 6-in. " ones and backward ones for " 2-in." and that therefore in designing a transplanting experiment the treatments should consist of seedlings of different ages rather than different heights. The plot sown with germinated seed gave a negligible yield.

Rice

Ceylon.—Reference to the progress of experiments on the science of paddy cultivation is made in the reports of Dr. J. C. Haigh, Economic Botanist, and Dr. A. W. R. Joachim, Agricultural Chemist, for the year 1934.

Dr. Haigh states that the third experiment of the series was carried out during Maha 1933–34 and Yala 1934. It enquired whether yield was affected by the time of application of phosphatic manures or by the form in which the phosphoric acid was applied. Both series were carried out in randomised replicated plots : in the first, broad ratio ammonium phosphate at the rate of 1 cwt. per acre was applied in one, two and three doses ; the series was duplicated by similar treatments with narrow ratio ammonium phosphate applied at such a rate that both halves of the series received the same amount of nitrogen per acre. The results indicated that in neither case was there any significant difference due to time of application of manure. The experiment was continued during Yala 1934 for the observation of residual effects, and again no significant differences were obtained.

Dr. Joachim states that schemes for the fourth series of trials were drawn up in collaboration with the Economic Botanist. The objects of the two trials in this series are : (1) to compare the effects of different rates of application of ammonium phosphate, (2) to determine the effects of single transplanting *v.* double transplanting *v.* broadcasting with and without manure. In connection with these trials, daily measurements were made since October of the strength of sunlight by a method depending on the amounts of free iodine liberated from the same quantities of a potassium iodide and sulphuric acid solution exposed to the sunlight for twenty-four hours. These data are to be obtained over a period of years so that it may be determined whether there is any relationship between the total amount and strength of sunlight during a growing period and the yield of paddy. Incidentally this investigation gives a relative measure of the strength and amount of ultra-violet light in the tropics and in temperate regions. Thus in Salford, England, during 1927 the maximum amount of iodine liberated during any month was 208 mgm.

and the minimum 42 mgm., with a total of 1,614 mgm. At Peradeniya, the average for the three months October, November, December 1934, was 372·9 mgm. of iodine liberated, the range of variation being only about 6 per cent. On this basis, the total amount of ultra-violet light during a year locally is nearly three times that in England.

Dr. Joachim mentions that the chemical data obtained in the third series confirm what was previously found in regard to the high proportions of nitrogen and phosphoric acid absorbed at flowering by transplanted crops, these being even higher than those found previously. The crops fertilised with narrow ratio ammonium phosphate show appreciably higher nitrogen absorption figures at flowering than those treated with wide ratio ammonium phosphate. The soil data reveal that in the small quantities applied, no consistently appreciable variations in available soil phosphoric acid, as determined by two methods, occur between samples from plots treated with different types of phosphoric acid fertiliser or from the same plot taken at different periods.

According to Dr. Haigh's report the second series tested the application of phosphoric acid as superphosphate, as ammonium phosphate, as steamed bone meal and as a mineral phosphate. Quantities were calculated so that each plot received the same amount of nitrogen and phosphoric acid as the narrow ratio plots in the first series, the additional nitrogen in three of the treatments being added as sulphate of ammonia. The series was continued during Yala 1934 for the observation of residual effects, but in neither season were there significant differences in yield between the treatments. The trials will be described in full in an article to be published in the *Tropical Agriculturist.*

Dr. Haigh, in his report, makes a brief reference to experiments in vernalisation, which have been carried out with paddy and with maize, the results of which have appeared in the *Tropical Agriculturist* (Vol. LXXXIII, No. 6, December 1934). Field trials with paddy have indicated that pretreatment of seed has the effect of shortening the period between sowing and flowering, but that under the conditions of the experiment the shortening is not sufficient to be of practical importance. It may be, however, that the effect would be increased by subjecting the seed to more drastic conditions.

According to the report of Mr. F. P. Jepson, Acting Entomologist, for 1934, the most prevalent pest of paddy during the year was the swarming caterpillar (*Spodoptera mauritia*) which was reported from many centres through-

out the island. The pest was particularly prevalent during December. In all cases extensive injury was reported, but the recognised control measures, when applied in time, resulted in the crops being saved.

A serious hindrance to the early control of the pest is the reliance placed upon "charms" by the peasantry, and it is only when these have failed and the pest has become widespread that the aid of the local Agricultural Officer is requisitioned. By this time, much damage has been caused and the caterpillars are well developed. The clearing of weeds and wild grasses in the vicinity of paddy fields, prior to sowing or transplanting, is an important precautionary method which, unfortunately, is rarely practised. If the attack is discovered on young plants the pest is readily controlled by flooding the fields, the insects ascending to the tops of the plants from which they are finally obliged to enter the water and are drowned. If the water level is slightly below the heads of the plants, the insects can be dislodged by dragging light coir ropes over the fields. If the plants have reached a height which does not allow of them being submerged by flooding, control is difficult.

Large areas of pasture land and of "chena" and vegetable cultivations were completely defoliated by the same insect in various centres of the island, particularly in the North-western Province.

Among other paddy pests received for identification and report were the stem borer (*Schœnobius bipunctifer*) from Delgamuwa near Ratnapura, Hesperid caterpillars from Polonnaruwa, *Marasmia bilinealis*, heavily attacked by parasites, from Anuradhapura, *Boralia venalba* from Ratnapura, *Parnara bada* from Talawa where much damage was caused, and the paddy gall fly (*Pachydiplosis oryzæ*), which causes the so-called "silver shoot" disease, from Wattegama and Anuradhapura.

The paddy bug (*Leptocorisa varicornis*) was again a prominent pest in many paddy-growing areas throughout the island.

Sugar

Cane

Leeward Islands, *Antigua*.—The following report on investigational work conducted in Antigua during the period June–December 1934 has been furnished.

The varietal trials at Millars, Jolly Hill and Fitches Creek reaped as plant canes during 1933 were reaped as first ratoons during the season under review. At Millars the lay-out was four randomised blocks and at Jolly Hill

six randomised blocks. At Fitches Creek there were two separate experiments in each case, the lay-out being six randomised blocks.

The following tables show the varieties cultivated at the various stations, the average yields in tons of cane and tons of sugar per acre, and the average sucrose content of the juice expressed in pounds per gallon.

TABLE I

MILLARS

Varietal Trial. First Ratoons.
Soil Type. Calcareous.
Reaped as plant canes, 7–11/2/33. Reaped as ratoons, 11–13/4/34.

Rainfall:

March–December 1933 . . .	37·75 in.
January–March 1934 . . .	2·60 ,,
Total . .	40·35 ,,

Average rainfall for similar period based on returns for ten years:

March–December	34·80 in.
January–March	5·17 ,,
Total . .	39·97 ,,

Variety.	No. of Replicates.	Cane per acre.	Sucrose per acre.	Sucrose in juice.
		Tons.	*Tons.*	*lb. per gal.*
B.4507 . . .	4	23·1	3·3	2·116
P.O.J.2878 . . .	4	22·5	3·4	2·272
B.417 . . .	4	20·5	2·9	2·129
B.11569 . . .	4	19·8	2·7	2·033
B.H.10.12 . . .	4	18·7	3·0	2·387
S.C.12.4 . . .	4	15·1	2·1	2·077

Differences in tons of cane per acre will not exceed 4·2 tons by chance more than once in twenty times. B.4507 is significantly better than B.H.10.12 and S.C.12.4, and P.O.J.2878 is significantly better than S.C.12.4.

TABLE II

JOLLY HILL

Varietal Trial. First Ratoons.
Reaped as plant canes, 1–4/5/33. Reaped as ratoons, 22–27/3/34.

Rainfall:

May–December 1933 . . .	36·74 in.
January–March 1934 . . .	5·14 ,,
Total . .	41·88 ,,

Average rainfall for similar period based on returns for ten years:

May–December	34·12 in.
January–March	5·65 ,,
Total . .	39·77 ,,

Variety.	No. of Replicates.	Cane per acre.	Sucrose per acre.	Sucrose in juice.
		Tons.	*Tons.*	*lb. per gal.*
P.O.J.2878 . . .	6	20·8	3·1	2·231
B.891	6	19·2	3·1	2·420
B.726	6	18·5	3·0	2·450
B.381	6	17·3	2·6	2·275
B.374	6	16·7	2·5	2·207
B.H.10.12 . . .	6	16·5	2·7	2·485

Differences in tons of cane per acre will not exceed 1·77 tons by chance more than once in twenty times. P.O.J.2878 is significantly better than B.726, B.381, B.374 and B.H.10.12. B.891 is significantly better than B.381, B.374 and B.H.10.12; B.726 than B.374 and B.H.10.12.

TABLE III

Fitches Creek (Section 1)

Varietal Trial. First Ratoons.
Soil Type. Calcareous heavy.
Reaped as plant canes, 21–28/2/33. Reaped as ratoons, 28/5/34–1/6/34.
Rainfall:

March–December 1933	38·01 in.
January–May 1934	6·31 ,,
Total . .	44·32 ,,

Average rainfall for similar period based on returns for ten years:

March–December	35·61 in.
January–May	10·47 ,,
Total . .	46·08 ,,

Variety.	No. of Replicates.	Cane per acre.	Sucrose per acre.	Sucrose in juice.
		Tons.	*Tons.*	*lb. per gal.*
B.11569 . . .	6	18·9	Analyses not available.	
P.O.J.2878 . . .	6	17·5		
P.O.J.213 . . .	6	14·9		
B.H.10.12 . . .	6	14·0		
B.4507 . . .	6	13·8		
G.140	6	12·5		

Differences in tons of cane per acre will not exceed 2·20 tons by chance more often than once in twenty times. B.11569 and P.O.J.2878 are significantly better than the other four varieties.

TABLE IV

FITCHES CREEK (SECTION 2)

Varietal Trial. First Ratoons.
Soil Type. Calcareous heavy.
Reaped as plant canes, 26–28/4/33. Reaped as ratoons, 4–7/6/34.
Rainfall:

May–December 1933 . . .	34·08 in.
January–May 1934	6·31 ,,
Total . .	40·39 ,,

Average rainfall for similar period based on returns for ten years:

May–December	32·48 in.
January–May	10·47 ,,
Total . .	42·95 ,,

Variety.	No. of Replicates.	Cane per acre.	Sucrose per acre.[1]	Sucrose in juice.[1]
		Tons.	*Tons.*	*lb. per gal.*
B.11569 . . .	6	21·8	3·3	2·291
P.O.J.2878 . . .	6	18·5	3·0	2·400
P.O.J.213 . . .	6	15·8	2·2	2·093
G.119. . . .	6	15·0	2·2	2·215
B.4507 . . .	6	11·9	1·7	2·080
G.140. . . .	6	7·7	1·1	2·119

[1] *Only two replicates analysed.*

Differences in tons of cane per acre will not exceed 3·5 tons by chance more often than once in twenty times. B.11569 is significantly better than P.O.J.213, G.119, B.4507 and G.140. P.O.J.2878 is significantly better than G.119, B.4507 and G.140.

B.4507 has maintained its reputation of being a good ratooning cane when grown on a light calcareous soil, having headed the list at Millars with an average yield of 23·1 tons per acre. This is especially noteworthy, as this variety gave easily the poorest yield when the experiment was reaped as plant cane.

It has at times been stated that P.O.J.2878 has proved disappointing when cultivated as a ratoon, owing largely to reduction in cane girth in the stubble crop. A large number of canes of small girth have indeed been observed in each of the four ratoon experiments in which this variety has been included, but notwithstanding this fact P.O.J.2878 has headed the list at Jolly Hill and occupied the second place both at Millars and Fitches Creek.

For the two crops, P.O.J.2878 has headed the list at Millars and Jolly Hill with a total yield of 80·3 tons per acre and 44·4 tons per acre respectively. At Fitches Creek (Section 1) it has occupied the second place with a yield of

55·1 tons per acre for the two crops, B.11569 occupying the first place with a total yield of 58 tons. At Fitches Creek (Section 2) it has headed the list with a yield of 62 tons per acre for the two crops, B.11569 occupying the second place with a yield of 58·8 tons.

Root Crops

Cassava

Uganda.—It is recorded in the report on experimental work conducted at Bukalasa during the period July to December 1934, that, in view of the importance of cassava as a famine reserve in Buganda, observations on resistance to mosaic are being made on the collection of varieties at present in existence. Several new local varieties have been obtained and are under observation.

Sweet Potatoes

Leeward Islands, *Antigua*.—The following report on investigational work conducted in Antigua during the period June to December 1934 has been furnished.

The varietal trial planted in July 1933 was reaped during the season under review. Six varieties were included and the lay-out consisted of four randomised blocks, each plot being $\frac{1}{64}$ acre in area. At the time of reaping it was discovered that the plots of New Jersey were not pure cultures, so that the yields from the plots of this variety have been disregarded.

The following table shows the mean yields of the five other varieties expressed as tons per acre :

Variety.	Yield in tons.
V.52	10·3
Red Nut	7·8
Moore	7·3
White Gilkes	6·5
Bert	6·3

Differences will not exceed 0·875 ton per acre by chance more often than once in one hundred times. V.52 is therefore significantly better than the other varieties. Red Nut is significantly better than White Gilkes and Bert, and Moore is better than Bert.

The above five varieties, together with Brooks Seedling, were again planted in a variety trial in June 1934. It is hoped from these two experiments to ascertain which of the varieties is the best suited for growing during the summer months. Experiments will then be conducted with potatoes planted during November and December.

Fruits

General

Ceylon.—Dr. A. W. R. Joachim, in his report on the Chemical Division, Department of Agriculture, for 1934, gives the following account of work carried out on fruit and fruit products.

Canning and Bottling.—A small food products laboratory was fitted up in the latter half of the year, but the apparatus could not be used to any extent, as the fruit season was over by then. The work was, however, carried out on the small hand plant previously obtained. A consignment of 146 tins of different varieties of canned fruit was sent to the Imperial Institute at the end of the year for report on the possibilities of a small industry in this line. A small package of ten tins of canned mangoes, pineapples, tree tomatoes and papaws was sent to England through a private channel and was reported on by the Director of the Campden Fruit Preservation and Research Station. The report was encouraging, considering that all the operations had been carried out by hand. It is considered that canned mangoes of the quality sent might command a market in England. The pineapples were reported on as being of quite good flavour, but the quality of the fruit itself was considered to require improvement in regard to fibrousness. The flavour of canned papaw was thought to be not very distinctive and probably not likely to appeal to the English public. Canned tree tomatoes were not considered to be likely to sell in England. In addition to the fruits experimented with previously, rambutans and soursop (in pulp form) were found to lend themselves successfully to canning and bottling.

Fruit Drying.—The sulphuring process adopted in drying temperate fruits was tried with ripe plantains with gratifying results. The product turned out was of decidedly superior colour and keeping quality to the ordinary dried plantain.

Gas Storage and Coloration of Fruit.—Cashew-nuts preserved in sealed tins of carbon dioxide and air alone, after thorough sun drying, were found to have kept well at the end of a storage period of twenty months. Interest in the colouring and artificial ripening of fruits is still unabated and a few growers have adopted the process commercially. Experiments have shown that Kew pines can be quite well coloured and their ripening appreciably hastened by the use of ethylene gas. The fruits so treated had a very fine flavour. In connection with artificial coloration, it may be recorded that as a matter of interest

trials were made with the coloration of common white flowers by the use of special aniline dyes. The results on the whole were satisfactory, the effects being quite pleasing with respect to certain colours and rather bizarre with others.

Cattle Food from Jak.—At the instance of the Forest Department, trials were made in regard to the preparation from unripe jak of a cattle food which would be of small bulk and good keeping quality. Slicing the entire fruit into small pieces, followed by partial sun drying, pounding in a mortar, pressing in a mould and a second sun drying resulted in a product which kept well. Oven drying where sun drying was not feasible at a temperature of about 45° C. was also found suitable. The meal was eaten by dairy cattle when mixed with other foods, provided a preliminary soaking in water was given. The meal is a carbohydrate food and it would appear to be of little advantage to prepare it when other carbohydrate foods are easily available. Further, at the present price of coconut poonac it would appear to be more economic to use the latter.

Bananas (Plantains)

Ceylon.—According to the report of Mr. Malcolm Park, Mycologist, Department of Agriculture, for 1934, bunchy-top disease continues to cause considerable damage to plantains, especially in areas where plantains are grown on a large scale. In one area in Alawa district, over 200 acres in extent, where plantains were grown as a catch crop in a reafforestation scheme, it was estimated that 90 per cent. of the clumps were diseased in the fourth year from planting. The reason for this extremely heavy infection is that a relatively large proportion of the suckers used as planting material were infected with bunchy-top disease. The procuring of suckers from the area in Magam Pattu which is free from bunchy-top disease would enable growers to avoid initial infection of their areas. It has so far been found impossible to persuade those who are opening new areas of plantains to adopt this procedure owing to the extra cost of planting material involved. It is, however, estimated that the extra cost would be more than repaid by the increased crops which would be obtained from areas in which the incidence of bunchy-top disease was so reduced. Legislative measures to enforce growers to use only healthy planting material would be impracticable with a crop like plantains, which is to be found in almost every village garden, but it is to be hoped that the personal influence and educational propaganda of the field officers

of the Department will in time lead to discontinuance of this and similar short-sighted practices.

There has been no evidence to show that the incidence of wilt or Panama disease has extended during the year. An interesting case of disease caused by *Fomes lamaœnsis* was observed. Plantains were growing on land which had previously been under *Hevea*, of which most of the roots had been left in the soil. *Fomes lamaœnsis* had spread from one such root and had attacked the plantain. The infected sucker was almost mature at the time of inspection and the flowering stalk had protruded. The diseased sucker displayed external symptoms similar to those caused by drought or by wilt disease. On examination, it was found that the fungus had penetrated the rootstock uniformly to a depth of about 3 in. from the cortical region. It is proposed to publish a further account of the disease later.

Citrus

Ceylon.—The following account of experiments with citrus fruits of different kinds is contained in the report of Mr. W. C. Lester-Smith on the School Garden and Experiment Station, Peradeniya, for 1934.

All citrus fruits received regular and careful attention throughout the year, and the weekly spraying of all plants with a combined sulphur and nicotine-oil spray mixture was regularly carried out. No cases of mildew (*Oidium tingitaninum*) attack were observed during the year and the degree of infestation by the citrus leaf-miner (*Phyllocnistis citrella*) was somewhat less than in former years.

Citrus canker (*Pseudomonas citri*) was kept well under control at the Station by the regular daily picking and burning of all affected leaves, and the incidence of this disease was very much less than in previous years. This is attributed partly to the continued dry weather as well as the careful attention to the daily picking of every leaf showing the slightest trace of this bacterial disease. It has been observed that there is almost invariably a slight increase in the degree of infection after every period of rain or increased humidity. From this it is obvious that there is no possibility of any complete control of this disease being attained by means of hand picking and that once some measure of control has been obtained by this means, the cessation of hand picking for even a few days during such periods invariably leads to a very marked increase in the incidence of the disease. There is not the slightest doubt therefore that the only reliable means of

effectively eradicating this disease from any definite area, as has been the experience of other countries, is to adopt the ruthless method of completely destroying by fire every infested plant on the site upon which it stands. It is definitely considered that until such measures are enforced there is little if any chance of successfully establishing a citrus industry in Ceylon on commercial lines, unless the species and varieties grown are those which are somewhat resistant to this disease. The only citrus types on this station which have exhibited any marked degree of resistance are those belonging to the lemon and the mandarin orange groups.

As a result of the existence of citrus canker and its occurrence on plants in the new citrus nurseries laid down for budding and grafting purposes, all propagation work of this nature for the external supply of plants has been definitely abandoned. All the seedlings in the new nursery area opened at the end of last year, and in which some of the plants were affected by citrus canker, were uprooted and destroyed. No distribution of citrus material will be carried out from the station, therefore, on account of the presence of this disease.

Two trees developed signs of a foot-rot trouble early in the year ; this appeared to be a form of gummosis and was treated as such by scraping away the discoloured bark and underlying tissue, and covering the exposed parts with a grafting wax. Both the trees are alive and fruiting, but it is believed that the infection is still latent in the plants and that the dry weather has prevented it from developing to any serious extent.

A few trees have shown definite indications of mottle-leaf, the cause of which is at present obscure.

Several cases occurred of fruits being attacked by fruit fly (*Dacus ferrugineus*) and at one stage all ripening fruit was plucked, kept for observation and destroyed with a view to preventing this pest from increasing. Much of the fruit so harvested was found to be attacked ; evidence of attack was in many cases not obvious on early picked and immature fruit, but was readily determined by keeping these fruits in a cupboard protected by a fine wire mesh from infection subsequent to picking. The attacked fruits soon show up readily in this way, the affected spots showing as soft, slightly discoloured areas, and later as a definite rotting, which is usually internal in origin.

Additions to the citrus fruit section during the year comprised fifty Walter variety budded grapefruit plants received from Florida in June, and planted to fill vacancies in the various fruit plots. Despite hand watering being done

when necessary, a few of these plants have not survived the drought periods ; in one or two cases in which the scions only have died the stocks are being allowed to grow up for re-budding at a later date and for propagation purposes.

All the citrus plants were given an application of artificial manure during the early part of the year, the mixture applied consisting of one part of sulphate of ammonia, two parts of muriate of potash, three parts of blood meal and four parts of superphosphate. This mixture was forked in round the base of the plants one or two feet from the stem according to the size of the plant. It was applied at the rate of ½ lb. per plant to all young plants, 1 lb. per plant to twelve to eighteen months old plants, 2 lb. per plant to all the 1931 plantings, and 3 lb. per plant to all 1927 and 1928 plantings. Later on in the year all plants received a dressing of compost manure, and the bases of all the plants were protected during the very dry periods with a surface mulch of *Gliricidia sepium* leaves. On the whole all the plants are looking healthy and their general appearance has considerably improved. A ground cover crop of *Calopogonium mucunoides* is being established and maintained in all the plots.

Grapefruit (*Citrus maxima* var. *uvacarpa*).—The fruiting records of all the 1928 planted grapefruit plants of South African origin are tabulated below, with their previous records.

Plot No.	Tree No.	Variety.	Number of fruits.		
			1932.	1933.	1934.
F 14	10	Cecily	7	2	1
F 14	7	do.	30	2	7
F 14	14	do.	—	3	—
F 14	1	Ellen	18	6	30
F 14	2	do.	75	7	1
F 14	3	Foster	22	10	2
F 15	17	Marsh's Seedless . . .	1	5	—
F 15	18	do. . . .	27	4	—
F 15	16	do. . . .	—	29	85
F 14	6	McCarty	1	1	—
F 14	11	do.	76	38	48
F 14	8	Triumph	26	51	91
F 14	9	do.	—	12	64
F 14	5	Walter	127	11	16
F 14	18	do.	—	13	—
			410	194	345
		Average per tree . .	37	12	35

The quality of the fruits produced by some of these trees has definitely improved, especially as regards flavour

and evenness of size, while many of the fruits produced have been less coarse and thinner-skinned than in previous years. Marsh's Seedless tree No. F 15/16, however, which bore well, had definitely degenerated in quality and produced poor-flavoured, thick-skinned fruits which have more of a pomelo than a true grapefruit flavour.

The fruiting records of two grapefruit plants imported in 1927 from Trinidad, B.W.I., are as follows :

Plot No.	Tree No.	Variety.	Number of fruits.		
			1932.	1933.	1934.
F 4	6	Walter	—	—	29
F 4	8	do.	—	20	23

Sweet Orange (*Citrus sinensis*).—A further year's records are given below for two of the three sweet orange plants imported from Trinidad, B.W.I. ; the third plant (No. F 15/4), a Lue Gim Gong orange, died some while after the leaves had become badly mottled, and was removed.

Plot No.	Tree No.	Variety.	Number of fruits.		
			1932.	1933.	1934.
F 15	1	Navel orange	4	32	4
F 15	2	Jaffa orange	19	79	50

This Jaffa orange has produced some excellent fruits as regards size and quality as well as apparently being a promising tree as regards yield. It is unfortunate, however, that this is one of the trees affected with foot-rot trouble.

Mandarin Orange (*Citrus nobilis*).—One Portugal Tangerine tree (No. F 15/6) also imported from Trinidad, B.W.I., in 1927, has now fruited for the second time. It produced two fruits in 1932, none in 1933, and twelve in 1934 ; of these twelve fruits, five were harvested in June and seven in September. The flavour and quality of these fruits have been very fair considering the age of the tree. The fruits are at present very variable in size, elliptical in shape and depressed at each end. They peel very easily, but the rag is rather coarse in all the fruits produced up to date.

According to the report of Mr. F. P. Jepson, Acting Entomologist, for 1934, the citrus leaf-miner (*Phyllocnistis citrella*) causes much injury to the leaves and young shoots

of various species of citrus in Ceylon. It is often, though not always, associated with citrus canker, which develops readily upon the mined surfaces.

Experiments with a view to controlling the pest by means of sprays were continued during the year, and it is now claimed that nursery stock can be kept free from the attacks of the pest by regular spraying with either an oil-emulsion containing 3 per cent. of nicotine, at the rate of 4 oz. in 4 gallons of water, or a concentrated nicotine-sulphate solution used at the rate of 2 oz. in 4 gallons of water, 4 oz. of good quality soap being previously dissolved in the water, in each case, before the addition of the other ingredient.

The experiments were conducted in collaboration with the Mycologist with the object of discovering a dual-purpose spray for the control of citrus canker as well as the leaf-miner. The sprays mentioned above having proved entirely satisfactory in controlling the leaf-miner, the experimental plots were handed over to the Mycologist for a continuation of his experiments against citrus canker (see also p. 217).

A summary of the bionomics of this pest and of measures for its control was published by Dr. J. C. Hutson and Mr. M. P. D. Pinto during the year.

An enquiry into the habits and life-cycle of the citrus leaf-roller (*Psorosticha zizyphi*) was conducted by Mr. M. P. D. Pinto and a summary of the conclusions arrived at was published during the year.

Mr. Malcolm Park, Mycologist, states that the relatively large number of specimens of diseases of citrus received for examination and report during 1934 may be regarded as an indication of the sustained interest in the cultivation of citrus trees rather than of any increase in the incidence of fungus diseases. Mildew (*Oidium tingitaninum*) was very prevalent in the early months of the year, and this fact, taken in conjunction with the wide-spread occurrence of *Hevea* mildew (see p. 234), tends to indicate that the weather conditions during this period were favourable for the attack and spread of powdery mildews. Further observations on the effect of spraying have shown that the disease is readily controllable by sulphur sprays. Colloidal sulphur is becoming increasingly popular as a fungicide for controlling this disease.

Citrus canker (*Pseudomonas citri*) continues to be the most serious disease of grapefruit and it is very common on lime. Neglected lime trees often provide the source from which healthy and expensive grafted grapefruit plants

become infected. The dry weather during the year has controlled the disease to some extent and this factor has been of great assistance to growers who have undertaken measures for eradicating canker from their trees. Further notes on this disease are given below.

Leaf-mottle or foliocellosis of grapefruit and orange is common, and is usually associated with insufficient root aeration and possibly with root infestation by the eel-worm *Tylenchulus semipenetrans*.

The major investigations of citrus diseases carried out by the Mycological Division have again been confined to the practical aspect of the determination of satisfactory methods of control of the common diseases. A series of nursery beds of sour orange (*C. aurantium*) plants has been sprayed regularly since 1933 with combined insecticides and fungicides in order to determine if a satisfactory combined spray could be discovered for combating the common insect pests and fungus diseases of nursery plants. The plants were sprayed each week and leaves attacked by citrus canker (*Pseudomonas citri*) were collected and destroyed from time to time. When the experiment had progressed for one complete year a comparison of the values of the different sprays was made. The dry weight of the leaves from each plant was determined and the whole treated statistically. The results show that, judging by dry weight of leaves, the plants sprayed with a combined spray consisting of colloidal sulphur, soap, nicotine sulphate and water were significantly larger and better than those sprayed with other mixtures and the unsprayed control plants. The plants sprayed with this mixture looked bigger and more healthy than those in the other plots. The full details of this experiment will be published elsewhere.

The control of citrus canker (*Pseudomonas citri*) continues to provide a major problem in the development of plantations of citrus, especially of grapefruit. As mentioned in Mr. Lester-Smith's report (p. 212), the collection and destruction of diseased leaves, fruits and green twigs has been continued at the Experiment Station, Peradeniya, and regular spraying undertaken. The result has been satisfactory, but in a wet district like that of Peradeniya the work has to be done with great thoroughness and regularity, otherwise it is found that considerable fresh infection takes place in wet weather. A similar trial has been made throughout the year at Nalanda Experiment Station, where there is an area containing ninety-four well-grown grapefruit trees about four years old. At the beginning of the year a great majority of the leaves on

every tree were badly infected. The first round of collection of diseased leaves entailed a virtual stripping of the trees, so severe was the infection. Spraying was done, regularly at first and latterly less frequently owing to the inactivity of the disease in the prolonged dry weather. The spray used at first was lime-sulphur and later a soap-colloidal sulphur-nicotine mixture was substituted. The trees were subjected to very dry weather from May until October, and there was considerable defoliation towards the end of this period. It was noted that cankered leaves were among the first leaves to be shed as a consequence of drought. As stated above, the collection of diseased leaves had involved virtual stripping and, as a result, some sun scorch of young branches and of immature fruits and some die-back of young branches was noted during the drought. With the advent of rains, however, the trees recovered well and the incidence of canker on the new foliage was relatively slight. The trees are now by no means free from canker, but their condition in this respect is markedly better than when the trial started. It would appear from the trials both at Peradeniya and at Nalanda that, by the regular collection and destruction of diseased leaves, twigs and fruits, combined with thorough spraying, the incidence of canker on grapefruit can be reduced to such an extent that it is no longer to be feared. The effect of the drought at Nalanda indicated that a climate in which there is a marked dry weather period is less favourable to the spread of canker than a climate in which the rainfall is more evenly distributed and that the disease is more easily controlled in the former climate.

During the numerous visits made to Nalanda in connection with the canker control work described above, observations were made on the relative incidence of canker on individual trees. No tree was found to be immune, but there appeared to be an indication of varying susceptibility to the disease in different trees. Further observations on this point will be made.

The following statement relating to the vitamin values of Ceylon citrus fruits is contained in Dr. A. W. R. Joachim's report on the work of the Chemical Division for 1934.

With the discovery that vitamin C, the anti-scorbutic vitamin, has been chemically identified with ascorbic acid, chemical methods have been devised for the assay of vitamin C in fruit juices, particularly citrus juices. One such method depends on the reduction of iodine by ascorbic acid. The iodine reduction figure of a citrus juice gives

a good idea of its vitamin C content. This method of vitamin C valuation has been employed with success in Californian citrus juice manufactories. Determinations made locally of various local juices showed the following results :

Fruit.	Condition.	Mgm. ascorbic acid (vitamin C) per gm. of juice.	
Lemon	Immature	0·34	
Local lime	do.	0·35	
do.	Green but immature	0·36	
West Indian lime	Mature	0·51	
Mindora	do.	0·30	
Sour orange	do.	0·39	
Lemon juice (Californian)	do.	0·57	Found by Bessey and King.
Grapefruit (Californian)	do.	0·53	
Orange (Californian)	do.	0·71	

It will be noted that limes, though considered at one time to be of poor vitamin C value, compare favourably with other citrus species grown in Ceylon. All the local varieties so far tested out show, however, comparatively lower vitamin values than the California-grown varieties. Further work on this subject is in progress.

Leeward Islands, *Dominica.*—Mr. F. G. Harcourt, Agricultural Superintendent, Dominica, reports that during the half-year ended December 31, 1934, experiments and demonstrations conducted in connection with various economic crops (and as outlined in previous reports) have been continued and there is little new to report.

The following headings are numbered in conformity with earlier reports :

1. *Lime Breeding.*—No tree combining all the good qualities of the West Indian Lime together with complete immunity from Withertip disease has yet appeared. The seedlings raised from the back crosses of the most promising hybrids and which have been budded or grafted on sour orange stock have been planted in the Department's trial grounds at Copt Hall.

2. *Stock Trials.*—Plots of limes budded on sour orange, grapefruit or rough lemon stocks have made good progress. The young trees are producing a good crop and records are being kept as to yield.

3. *Grapefruit and Oranges.*—It is too early to submit information concerning variety and stock trials with these fruits.

4. *Government Fruit Farm.*—Detailed cost accounts are kept covering all operations at this farm. Growth development of the trees compares very favourably with that of trees planted on estates. It is, however, felt that progress is backward when compared with similar plantings

in the more southern islands of Trinidad and St. Lucia. No diseases caused trouble, but attacks by scale and beetles have necessitated a good deal of spraying.

5. *Plant Distribution.*—Propagation of budded citrus plants has been continued on a large scale. All nursery stock is in a clean and healthy condition. The demand for grapefruit plants has fallen off in consequence of the poor prices ruling for this fruit and the fear of over-production in the future. The demand for budded limes and oranges is well maintained. Plants distributed during the half-year under review include: 2,831 grapefruit, 9,480 limes and 4,248 oranges.

6. *Economic Section, Botanic Gardens.*—Work in re-modelling this section of the Gardens has been continued. The various economic plants, plots of which were previously reported as being planted, have made satisfactory progress.

7. *Demonstration Plots, Experiment Station.*—In addition to the stock trials for limes mentioned under Head 2, plots of citrus established with the object of demonstrating the value of proper cultural methods have been maintained in good order. Cost accounts have been kept throughout the year covering all operations performed. It is hoped that statistics from these will supply information of value to growers concerning the economical management of lime plantations.

8. *Top-working Lime Trees.*—The exceptionally dry weather experienced during the year was responsible for the death of several trees which had been operated on. Those which have survived have made vigorous growth on the coming of the rains.

Leeward Islands, *Montserrat.*—Mr. C. O. Jones, Curator of the Experiment Station, Montserrat, in his report for the six months ending December 31, 1934, states that the seedling lime trees continue to show more vigour to combat unsuitable climatic conditions than the budded limes, and as a consequence the output of budded lime plants has been very much reduced.

Spices

Chillies

Ceylon.—Mr. Malcolm Park, Mycologist to the Department of Agriculture, in his report for 1934, states that two diseases of chillies came into prominence towards the end of the year. At Anuradhapura, leaf-spot caused by *Cercospora capsici* was prevalent on young plants. This is

the first time that the disease has been recorded in Ceylon, although it is probable that the disease has occurred before but not so seriously as to attract attention. Spraying is being undertaken in an endeavour to control the disease. At Wiraketiya chilli station there has been a severe outbreak of little-leaf disease on young plants. The disease is distinguished by the prolific production of dwarf leaves and badly affected plants often die back. Diseased plants rarely produce fruits, and these are usually small and distorted. It is possible that the disease is caused by a virus and the occurrence of the disease on solanaceous weeds (*Solanum nigrum* and *Solanum* (?) *lœve*) growing in the vicinity would appear to support this view. On the other hand there have been reports, unfortunately not supported by specimens, that affected plants may recover and grow normally, so that it may be a physiological disease. The results of severe mite infection may possibly be confused with little-leaf disease. The severity of the outbreak, almost 100 per cent. of plants in five acres being affected, is thought to be correlated with an insufficiently long rotation period. Other diseases of chilli recorded during the year have included collar rot caused by *Sclerotium Rolfsii* and fruit rots caused by *Vermicularia capsici* and *Glœosporium piperatum*.

Ginger

Ceylon.—Mr. W. C. Lester-Smith, in his report on the School Farm and Experiment Station, Peradeniya, for 1934, records that an area of one and a half acres was laid out in plots of 360 sq. ft. for ginger experiments. Three separate experiments were carried out on behalf of the Agricultural Chemist, the Economic Botanist and the Mycologist. The objects for which the respective experiments were designed were as follows : (1) To compare the effect of a straw mulch with that of an equivalent quantity of potash on the yield of ginger. (2) (*a*) To attempt to find a spacing whereby the larger percentage increase resulting from the use of small planting setts may be combined with maximum yield per acre ; and (*b*) to compare the shape of hands produced by large and small setts. (3) To compare the early and late sterilisation of ginger rhizomes before planting. This experiment is referred to further in the Mycologist's report (see p. 222). The seed ginger used was received from a crop raised at Giragoda by the Central Divisional Agricultural Officer. This seed ginger unfortunately developed a fungus disease, caused by *Sclerotium Rolfsii*, and on separating out infected and non-infected rhizomes the material was found to be of

two types. These were separated by the Economic Botanist and the bulk of the seed ginger consisted of what is locally known as "Nugegoda ginger" and a small quantity of the Cochin type which was planted separately for purposes of multiplication.

Details are not yet available of the yield records from all the plots, but largely owing to the drought, and partly also to the small size of the planting pieces necessitated by the sorting and separation of diseased material, the crop was practically a failure. Some of the plots were also badly infested with Kora grass, of which it was quite impossible to rid them by implemental tillage; in spite of hand weeding it was not possible to control this grass effectively, so that the ginger also suffered severely from competition with Kora during the drought. Even the plots receiving a surface mulch were affected to varying degrees and the stand of ginger obtained was extremely poor. A count in all plots made in the middle of November showed the losses to range from 24 to 99 per cent. The plots were not ready for harvesting before the end of the year.

Mr. Malcolm Park, Mycologist, in his report for 1934, states that the fungus causing the disease thought to be soft rot and discussed in the last report (see this BULLETIN, 1934, **32**, 293), was identified by Mr. S. F. Ashby of the Imperial Mycological Institute as *Pythium graminocolum*, and not, as was suspected, *P. Butleri*. The fungus has usually been found in Ceylon in conjunction with *Rhizoctonia solani*. The field experiment suggested in the last report has been carried out during the year. "Seed" ginger was selected and divided into three lots. The first lot was treated by soaking it in a 0·1 per cent. aqueous solution of corrosive sublimate for two hours soon after harvesting, the second lot was similarly soaked just prior to planting, and the third lot was untreated and served as a control. The ginger was planted in plots in such a manner as to render possible the statistical treatment of results. Many more plants grew in the treated plots than in the untreated plots. Unfortunately the prolonged dry weather affected the crop very adversely and it may be found impracticable to harvest the crop adequately. It is thought, however, that statistical analysis of the number of plants growing in the different plots will give a good indication of the value of the treatment. This analysis is in progress and the results will be published later.

Dr. A. W. R. Joachim states that during the first quarter of 1934 a great deal of time and attention was

devoted by the Chemical Division to work in connection with the manuring and curing of ginger. The manurial and cultural experiments begun in April 1933 were completed during the period and the yield data analysed. A paper on the subject was submitted for publication in *The Tropical Agriculturist.* The trials have indicated that: (1) local ginger is a significantly better yielder than the Nugegoda variety; (2) manuring with artificials at the rate of 5 cwts. per acre is equivalent to manuring with cattle manure at 9·2 tons per acre, an increased yield of over 1 ton per acre being obtained by such manuring; (3) a straw mulch produces a significant increase in yields; (4) liming is no advantage from the standpoint of yield; (5) the yields of ginger vary appreciably with the soil type. The experiment started at the School Farm to determine whether the increased yield of ginger through mulching with straw is due more to the potash content of the latter than to its physical and biological effects on the soil, has unfortunately failed owing to the prolonged drought affecting crop growth.

No less than three tons of local ginger and one of Nugegoda ginger were cured at Giragama by the ordinary curing methods, the former for grinding and local sale and the latter (clean peeled) for export purposes. As the Nugegoda ginger was a mixed sample and the weather conditions were not ideal, rain having fallen unexpectedly on two occasions, the out-turn of Grade I clean-peeled Nugegoda ginger was not as high as it might have been, but the results on the whole were quite satisfactory.

Four cwts. of the coarse-peeled dried ginger were ground at a mill in Matale, pending the erection of the mill ordered for this Division, in two grades—fine powder and coarse powder (20/60 mesh). Of this quantity 3½ cwts. were supplied to the Medical Department, and about ½ cwt. to local druggists and chemists. A further ½ cwt. was subsequently ground and supplied to the Medical Department, and ¼ cwt. offered free of charge in view of the prevailing malaria epidemic. One cwt. of coarse-peeled whole ginger was supplied to the Medical Department and about 5 cwts. to a local firm, the price obtained from the latter being slightly higher than that ruling for first-quality Cochin ginger.

A sample of clean-peeled ginger prepared without any lime or sulphur was sent to the Imperial Institute for report and valuation. This ginger was very favourably reported on, there being an immediate demand for all the ginger of this grade that could be produced. The prices offered were from 55*s.* to 60*s.* per cwt. for Grade I and

45s. to 50s. for Grade II. At these prices there is not much margin of profit, peeling costs being very heavy. But better prices could be hoped for. For other reasons, however, the whole quantity of about 2 cwts. was sold locally. The total returns from the sale of dried ginger during the year amount to Rs.478/67.

The quality of the local ginger supplied has apparently been so satisfactory that an order for the supply of 9 cwts. of this ginger has been placed by the Medical Department this year.

Lawn Grasses

Uganda.—As mentioned in this Bulletin (1934, **32**, 583), trials are being made at the Botanic Gardens, Entebbe, with the following grasses for lawn purposes: *Axonopus compressus*, *Brachiaria decumbens*, *Chloris pycnothrix*, *Cynodon dactylon*, *Cynodon transvaalensis*, *Eragrostis Mildbrædii*, *Paspalum notatum* and *Pennisetum clandestinum*.

According to the report on the Gardens for the period July to December 1934, no definite conclusions have so far been arrived at from a study of the various plots. It was observed, however, that *Paspalum notatum*, *Eragrostis Mildbrædii* and *Cynodon transvaalensis* remained greener in colour through the dry spells, and, with the addition of *Brachiaria decumbens*, covered their respective plots in a more uniform manner. *Cynodon dactylon* and *Pennisetum clandestinum* became thin in many places during the dry weather, consequently letting in weeds and certain alien grasses more freely, whilst *Axonopus compressus* almost dried up and obviously requires moist and shady conditions in order that it may thrive to any great extent.

Oil Seeds

Chaulmoogra

Ceylon.—Mr. W. C. Lester-Smith, in his report on the School Farm and Experiment Station, Peradeniya, for 1934, includes the following accounts of work done on plants yielding Chaulmoogra oils.

Taraktogenos Kurzii.—The trees on the west side of the terraced valley, in block "A," which were seven years old in May, have continued to make better growth than those in block "C," especially those which do not receive the same amount of light and wind protection. The former range in height from $2\frac{3}{4}$ to $18\frac{1}{4}$ ft. with an average of about 10 ft.; while the latter range from $1\frac{1}{4}$ to $13\frac{1}{2}$ ft. in height.

For the first time flowering has been recorded this year; six trees in block "A" flowered, five in February, and one in July, but none set any seed. The terraces on which these plants are established have been regularly weeded and all the *Gliricidia sepium* wind-break trees, which were no longer required, were removed from both blocks "A" and "C."

Hydnocarpus anthelmintica.—A few plants of this tree were planted along the river bank in the dwarf coconut plot after the floods in June 1933. These have made very good growth and are now strong and healthy plants varying between 4 and 6 ft. in height.

Uganda.—The following statement relating to the trials which are being made with *Hydnocarpus* spp. is contained in the report on the Botanic Gardens, Entebbe, for the period July to December 1934.

Hydnocarpus Wightiana.—One tree has succumbed to an attack of "wet root rot" (*Armillaria mellea*) and another tree beside it has since taken on a sickly appearance. A healthy appearance has been maintained otherwise.

Sixteen out of thirty-five trees have now developed sufficiently to be distinguished as female, and seventeen as male, leaving two as yet to be determined.

A small first crop of fruits was harvested during the period under review, and at the end of December two further crops, both very immature, were in evidence. Fruits collected were rather small as a whole and contained an average of but 10·7 seeds only.

Hydnocarpus anthelmintica.—Good upward, rather than lateral growth, has been made by this species, excepting where laterite is near the soil surface. Ten out of the thirty-six trees have proved to be female.

A much smaller first crop than from *H. Wightiana* was harvested prior to the end of September, but fruits were larger and contained an average of 30·1 seeds each.

Samples of seeds from both species have since been handed over to the Medical Department in order to obtain reports.

Coconuts

Ceylon.—The following account of pests of coconuts recorded during 1934 is contained in the report of Mr. F. P. Jepson, Acting Entomologist, for that year.

Extensive damage to coconut palms was occasioned by the coconut caterpillar (*Nephantis serinopa*) in the Eastern Province. An attempt is to be made to control this pest by biological methods. A special officer was

seconded to this Division on December 1 for training in parasite breeding work preparatory to collecting and breeding the Eulophid pupal parasite (*Trichospilus pupivora*) in a suitable centre to be decided upon later.

The coconut caterpillar problem in the Eastern Province is one of long standing. The severity of the recent outbreak has been aggravated by drought, and the control measures of cutting and burning infested leaves, prescribed by the Plant Protection Ordinance No. 10 of 1924, are considered, in drought periods, to impose an unnecessarily severe tax on the already weakened palms.

Another important pest of this crop reported during the year was the coconut scale (*Aspidiotus destructor*) which was widespread, and caused much damage on four estates in the Chilaw district. The prevalence of the pest was attributed to drought and the shortage of the predaceous lady-bird beetle, *Chilocorus nigritus*. The same pest was also reported from Wariyapola and Dandagamuwa.

An outbreak of the black beetle (*Oryctes rhinoceros*) at Chilaw was reported. Specimens of *Phyllognathus dionysius* which belongs to the same family (*Scarabæidæ*) as the black beetle were received from an estate near Pannala in the North-western Province, where the insect was found to be abundant in buried green manure. The larvæ superficially resemble those of *Oryctes* and those of cockchafer beetles (*Melolonthidæ*); in fact this insect is known as the Rice Cockchafer in India. There are certain evident characters by which these three species of larvæ may be distinguished, but it is not improbable that the discovery, in decomposing green manures and other media, of *Phyllognathus* and Melolonthid larvæ has led to the assumption that they are those of *Oryctes rhinoceros*. *Phyllognathus dionysius* feeds on the roots of certain plants, but there is no evidence, at present, of the roots or other portions of coconut palms being damaged by these insects.

Roots of coconut palms were reported to be damaged by cockchafer grubs at Gampaha. Similar injury does not appear to have been observed in Ceylon before. These insects, which are serious pests of lawns by feeding upon the roots of grasses, also occur in trenches in which green manures have been buried on coconut estates. It is probable that the injury reported in this case was of a casual nature. The ground surrounding the palms was heavily infested with the grubs and some damage to the net-work of palm rootlets in the area might be expected.

The spotted locust, *Aularches miliaris*, which is occasionally reported as a pest of coconuts, caused injury on an

estate near Alawwa. The same insect defoliated Areca palms at Tyspane, near Nawalapitiya, other crops being involved in the same outbreak.

Porcupines caused serious injury to young coconut palms at Polgahawela. The destruction of these rodents in their subterranean runways appears to be the most satisfactory form of control.

Silvanus surinamensis, commonly known as the saw-toothed grain beetle, infested exported desiccated coconut to such an extent as to lead, in one instance, to the delivery of a large consignment being refused on arrival in Europe. As in the case of the infestation of shipments of tea by *Psocidæ*, referred to on page 202, the source of infestation has not yet been traced. The shippers suggest the likelihood of infestation during transit, a responsibility which the shipping company concerned is not prepared to accept without proof.

The report of Mr. Malcolm Park, Mycologist, for 1934, records that experiments to determine the possibility of controlling the coconut beetle (*Oryctes rhinoceros*) by using traps infected with the green muscardine fungus (*Metarrhizium anisopliæ*) have been continued during the year. Traps consisted of small pits about 2 ft. square and 1½ ft. deep, filled with coconut debris mixed with fresh cattle dung. No infection was made until it was established that the traps had attracted female beetles and that healthy larvæ were present in all. The inoculum consisted of pure cultures of the fungus on boiled rice, and for inoculation this was mixed thoroughly with the contents of the traps. One-half the traps were inoculated and the remainder served as controls. Subsequent examination showed that the fungus attacked and killed all the larvæ present in infected traps. The fungus was later observed to have infected larvæ in one of the control traps. The presence of the fungus in this trap may be explained either by wind-borne spores or by being carried on the coat of insects or rodents.

This experiment established the fact that larvæ living under natural conditions were readily infected by artificial inoculation. A further and important step came to light in subsequent examinations of the infected traps. It was found that young larvæ continued to appear and that they were soon infected and killed by the fungus. On one occasion, six months after the inoculation, an egg of the *Oryctes rhinoceros* was found in one of the infected traps, together with young larvæ attacked by the fungus. It would appear, therefore, that infected traps may continue

to attract egg-laying female beetles and that a single inoculation with the fungus supplies infectious material for many months. Fresh cattle dung and coconut material have been added to the traps from time to time and observations are being continued.

Metarrhizium anisopliæ has hitherto not been recorded in nature in Ceylon at an elevation below 1,500 ft. A natural infection has recently been reported from Kochchikadde at an elevation but little above sea-level. Traps were prepared on the lines described above for a trial with the fungus under estate conditions. Examination of the traps prior to inoculation disclosed the presence of the fungus in an active condition. While it was therefore impossible to carry out the proposed experiment, an attempt is being made to utilise the natural occurrence of the fungus for controlling the beetle in that area.

Reference to the further work on the yield of the group of palms affected by "root disease" is also made in Mr. Park's report. The yields of many of the palms have shown a marked decrease, but adverse weather conditions may have been contributory. The area was visited and further examinations of roots of affected palms were made. As in the past, no evidence of the action of parasitic fungi could be obtained. There is no indication of a progressive spread of the disease from tree to tree. The degeneration of affected palms is very slow and supplies planted in the holes from which affected palms were removed show no sign of infection. The investigation into the effect of drought on the yield of coconuts on certain estates in the Puttalam district was concluded during the year. The results were published in the *Tropical Agriculturist*, Vol. LXXXIII, 1934, p. 141.

Further inoculations were made with pure cultures of *Thielaviopsis paradoxa* on the young developing leaves of coconuts. In the first series the inoculations were made at the base of the youngest unfolding leaf. Infection was observed after five days in the wounded inoculations. Infection was localised and did not involve the bud. No infection took place in unwounded inoculations and in the wounded controls. In the second series, inoculation was made by injection with a hypodermic syringe of a suspension in water of the spores of the fungus at a point near the bud. Infection was observed within two days and this spread rapidly. The young developing leaves soon wilted and the trees gave every indication of being infected with bud-rot. Dry weather followed and the development of the disease was checked. Subsequently the tree

recovered, indicating that the bud was not affected. The control palm was unaffected. It is suggested that in wet weather the infection in the region of the bud would have progressed further. The experiment will be repeated.

Ground-nuts

Uganda.—The following reports on experimental work conducted at the Serere Plantation and at Bukalasa, during the period July to December 1934, have been furnished.

Serere Plantation.—A ground-nut variety, spacing and mulching trial was carried out. The experiment consisted of six blocks of the following twelve treatments: Two varieties of ground-nuts, "Bunch" and "Spreading." Three spacings, 12 × 12 in., 9 × 9 in. and 6 × 6 in., all combined with mulching and clean weeding.

The results obtained showed that:

(1) The yields from the "Bunch" variety were significantly better than those from the "Spreading" variety.

(2) Mulching increases the yield of the "Bunch" variety.

(3) There was no significant difference between the spacings.

(4) "Bunch" variety had significantly less rosette disease than "Spreading" variety.

(5) The 12 × 12 in. spacing had more rosette disease than the 9 × 9 in. and 6 × 6 in. spacings.

A trial to compare hand-lifting of ground-nuts, grown on ridges and on the flat, with lifting by the use of a Ransome's E.C. plough, with the breast removed, and a lifting implement made locally, was also carried out. The weather conditions were bad when the nuts were lifted and the soil was wet and sticky. On this account the lifting implement became clogged, while the plants lifted by the plough were plastered with soil; consequently, hand-lifting proved to be the most economical under the circumstances.

Bukalasa.—In a variety trial with ground-nuts, the following results were obtained:

Variety.	Yield per acre (unshelled). *lb.*
Virginia Bunch (Bukalasa)	2,144
Bukalasa Bunch	1,960
Tanganyika Bunch	1,789
African Bunch	1,780
Philippine Pink	1,260
Virginia Bunch (Serere)	1,175
Least significant difference	219

Virginia Bunch (Bukalasa) thus gave a higher yield than all other varieties except Bukalasa Bunch. Philippine Pink and Virginia Bunch (Serere) yielded less than any other varieties.

A cultural test, including mulching and various spacings, gave the following results :

Treatment.	Yield per acre (shelled).
	lb.
2 × 2 ft.	625
2 × 2 ft. (mulched)	490
1 × 1 ft.	1,100
1 × ½ ft.	1,390
Least significant difference	440

Both the closer spacings gave significant increases in yield over the wider spacing and mulching had no beneficial effect.

Oil Palm

Uganda.—The following reference to work on the oil palm (*Elæis guineensis*) is contained in the report on the Botanic Gardens, Entebbe, for the last half-year of 1934.

From July to December there were on an average thirty-four palms in bearing each month, and approximately 6,085 lb. of fruits (fresh weight) were collected from these during the period. The largest amount produced during any one month was 1,462 lb. (in September), the highest individual yield at any one harvesting being 153 lb. 10 oz.

Seedlings from Nigerian seed have continued to make good progress, much more so than those from seed of the highest yielders at Entebbe. This result, however, may be largely due to the dry climatic conditions which followed the transplanting of the latter (a short period elapsing between the two), rather than to the particular strain of the former.

Tung Oil

Ceylon.—The following statement relating to the work carried out on *Aleurites montana* at the Experiment Station, Peradeniya, is contained in Mr. W. C. Lester-Smith's report for 1934.

Twenty-five plants of the first planting, June 1930, in Block B of the terraced valley, flowered during the year ; eight flowering in February, twelve in March and five in April. The majority of the inflorescences bore male flowers only, but a few pistillate flowers were noted which

showed indications of setting and forming fruit. It was hoped, therefore, that a first small crop of seed would be obtained from these young trees, but most of those which commenced to set seed fell during the dry weather and only four trees, Nos. 1, 6, 68 and 81, produced one fruit each. Six vacancies were supplied during the year, making the total number of plants up to 138, one of which died subsequently. All the wind-break trees of *Gliricidia sepium* in this area were lopped and the loppings mulched round the tung oil plants.

In January all the Aleurites plants were manured with a mixture consisting of four parts of sulphate of ammonia, two parts of blood meal, three parts of superphosphate and one part of muriate of potash. This mixture was applied at the rate of half a pound per plant under one year old, one pound per plant one year but not two years old, three pounds per two-year-old plant, four pounds per three-year-old plant, and five pounds per plant over three years old. This mixture was forked in on the terraces in circles round the base of the plants at distances varying from 1 to 2 ft. away from the plants according to their size. Since this manuring all the plants have made more rapid growth and they are now in very good condition.

Girth and height records were taken in February when the first-established plants showed an average height of approximately 6 ft. with an average girth of about 7 in. Height and girth records cannot be correlated because many of the plants were topped in their early stages to promote low branch formation ; in spite of this, however, some trees tend to grow vertically and produce a sparse branching habit. The tallest tree had a height of 9¼ ft. with a girth of 7¾ in. ; while several others had a girth, taken at the first branching place, of 10 in. or over.

The one fourteen-year-old tree in bearing near the store, which it has not yet been possible to move to its selected site behind the office, produced the poor crop of 168 fruits during the year, the cropping season of which extended from July to December inclusive. The 1931, 1932 and 1933 crops produced 262, 265 and 364 fruits respectively. A further ten fruits, which are not yet ready for harvesting, still remain on this tree, which branches very low within 1 ft. from ground-level, has a height of 15 ft. and an even all round lateral spread of 20 ft. As some of the 1934 crop was sold for seed in the fruit form, as the viability of the seed is reported to be more reliable after transport in the tropics in this form, no record is available of either the number or weight of seeds obtained.

Fibres

Cotton

Leeward Islands, *Montserrat.*—Mr. C. O. Jones, Curator of the Experiment Station, Montserrat, in his report for the half-year ending December 31, 1934, states that the selfing of cotton flowers in the cotton-breeding plots was carried out on the lines of previous years. Selfed seed cotton was collected from the 2,070 individual plant selections. Three hundred boll tests were made on sixty-nine progeny rows. Laboratory analyses of the seed cotton for special factors were also made and frequency charts were made for Lint Index, Seed Weight, Ginning Percentages, Lint per Boll and Lint Length. From these factors final selections were made in consultation with Dr. Harland, Cotton Adviser. The effect of selection still shows a marked improvement with the island's cotton. This is shown in the raising of the Lint Index and ginning out-turn after so many years of intensive breeding.

Rubber

Para

Ceylon.—The following account of the New Avenue rubber manurial experiment, conducted at the Experiment Station, Peradeniya, is contained in Mr. W. C. Lester-Smith's report on the Station for 1934.

The fourth year of this experiment comprised the period, April 1, 1933, to March 31, 1934. The object is to compare the influence on yield of the three treatments: single nitrogen, double nitrogen, and a complete mixture against a non-manured control. The manurial applications are made annually in the first week of December. The whole experiment comprises twenty plots, each containing twenty trees, there being five randomised replications of each of the four (including the control) treatments. Details of the treatments are as follows: Single nitrogen—2 lb. sulphate of ammonia per tree per annum = 40 lb. per plot = 40 lb. nitrogen per 100 trees. Double nitrogen—4 lb. sulphate of ammonia per tree per annum = 80 lb. per plot = 80 lb. nitrogen per 100 trees. Complete mixture—2 lb. sulphate of ammonia, 2·2 lb. superphosphate and 0·8 lb. muriate of potash per tree per annum = 40 lb. sulphate of ammonia, 44 lb. superphosphate and 16 lb. muriate of potash per plot = 40 lb. nitrogen, 44 lb. phosphoric acid and 40 lb. potash per 100 trees. Control—no manure, but the same forking treatment as received by the other plots at the time they receive their respective manurial applications.

On the same basis as calculated in previous years, that is, on the basis of the actual number of trees in tapping per plot, and excluding any trees that may have gone out of tapping as a result of brown bast disease or other causes, the yield records for the fourth year were as follows :

NEW AVENUE RUBBER MANURIAL EXPERIMENT

Yields per tree in Grams (1933–34)

Treatments.	Block 1.	Block 2.	Block 3.	Block 4.	Block 5.	Totals of treatments.	Mean.
Single nitrogen .	1,755	1,470	2,390	1,743	1,559	8,917	1,783·4
Double nitrogen .	1,531	1,674	2,653	1,876	1,651	9,385	1,877
Complete mixture	1,714	1,930	2,099	2,042	1,817	9,602	1,920·4
Control . .	1,387	1,386	2,474	2,214	1,642	9,103	1,820·6
Totals of blocks .	6,387	6,460	9,616	7,875	6,669	37,007	—
Mean . .	1,596·7	1,615	2,404	1,968·7	1,667·2	—	—

General Mean—1,850·3

The means of the treatments have been summarised on this same basis for the whole of the past four years, during which this experiment has been in progress and the results are set out hereunder :

NEW AVENUE RUBBER MANURIAL EXPERIMENT

Summary of means of treatments for the four-year period 1930–34 (on the basis of the actual number of trees in tapping, as per previous reports)

Mean yield per tree in Grams

Year.	Single nitrogen.	Double nitrogen.	Complete mixture.	Control.	General mean.
1930–31 . .	1,281·0	1,215·6	1,265·4	1,146·8	1,227·2
1931–32 . .	1,609·0	1,517·4	1,635·4	1,422·2	1,546·0
1932–33 . .	1,545·6	1,637·0	1,724·4	1,528·6	1,608·9
1933–34 . .	1,783·4	1,877·0	1,920·4	1,820·6	1,850·3

It has been contended, and rightly so it is considered, that no absolutely accurate statistical analysis of these results is possible unless the means be calculated on the basis of the full number of trees per plot (i.e. twenty), without taking account of those which go out of tapping, either temporarily or permanently, from causes which might in any way be attributable to the treatments they have received. As no trees have gone out of tapping through lightning or other causes outside the scope of the experiment, each of the four years' records has been recalculated and summarised on this basis. It has not been possible to examine or analyse these records statistically,

but in view of their more accurate nature, which gives them a greater value, a summary of the means of the respective treatments on this basis is set out below for comparison with the foregoing table.

NEW AVENUE RUBBER MANURIAL EXPERIMENT

Summary of means of treatments for the four-year period 1930–34 (on the basis of the full number of trees per plot, i.e. twenty, irrespective of those out of tapping)

Mean yields per tree in Grams

Year.	Single nitrogen.	Double nitrogen.	Complete mixture.	Control.	General mean.
1930–31 . .	1,281·0	1,234·0	1,265·6	1,183·6	1,241·0
1931–32 . .	1,562·2	1,447·4	1,615·4	1,391·4	1,504·1
1932–33 . .	1,472·4	1,466·8	1,543·8	1,409·0	1,473·0
1933–34 . .	1,691·8	1,684·8	1,729·2	1,652·0	1,689·4

There appear to be definite and continued indications that all manured plots are giving slight increases in yield over the unmanured controls, and also that the complete mixture plots are giving rather more appreciable and increasing yields compared with the single and double nitrogen treatments. The experiment is being continued.

Mr. Malcolm Park, Mycologist to the Department of Agriculture, reports that Hevea mildew (*Oidium heveæ*) has been the outstanding rubber disease during 1934. In the early months of the year it was unusually severe on mid-country estates, and a new and somewhat alarming feature was its widespread occurrence in the low-country districts where it had hitherto been negligible. It is possible that in certain low-country districts the severe attack was associated with weather conditions which are unlikely to recur in a normal year. Treatment in these districts is unlikely to be essential. On the other hand, the view is widely held that the disease will continue to cause serious damage at mid-country elevations unless control measures are undertaken, and it is significant that many estates are proposing to carry out the sulphur-dusting treatment in 1935. The Mycologist, Rubber Research Scheme, is continuing to give the disease his close attention and has demonstrated to planters in many districts that the sulphur-dust treatment is practicable under estate conditions.

There has been a noteworthy increase in the incidence of brown bast on many mid-country estates and it is

thought that this is associated with the repeated defoliation caused by *Oidium*. A tapping system which is normal for healthy trees becomes too severe when trees are denuded of their foliage, and consequences of overtapping, of which the occurrence of brown bast is one, then become apparent.

Fomes lignosus and *Ustulina zonata* continue to take their toll in the wetter districts, particularly on estates where control measures were neglected during the years of depression.

The diseases caused by *Phytophthora palmivora* were not much in evidence during the year owing to the failure of the south-west monsoon rains. The effect of the prolonged dry weather was reflected in the early and irregular wintering of trees.

Tobacco

Mauritius.—The following statement on tobacco production in Mauritius during the season 1934–35, prepared by Mr. Geoffrey Corbett, Government Tobacco Officer, has been furnished to the Imperial Institute by the Colonial Office.

Production.—During the year under review, the Tobacco Board issued 327 certificates for the cultivation of 1,080½ acres in tobacco, as compared with 1,239 certificates for the cultivation of 2,081¼ acres in the preceding year. This restriction was rendered necessary by the production of the previous year being greatly in excess of the requirements of the local market. The total acreage registered was not fully planted, owing to drought, and the following table shows the acreage cultivated.

Table I

Type.	1933–34 *acres.*	1934–35 *acres.*	Decrease. *per cent.*
Flue-cured	981	676	31·1
Air-cured	1,100¼	245	77·7
Total	2,081¼	921	55·8

Crop Conditions.—At the commencement of the year drought conditions delayed planting, but good rains towards the end of May enabled those planters who had seedlings ready to do their planting under favourable conditions. Unfortunately, owing to the early drought conditions, plantations in those districts which have to rely on irrigation had in the main to be curtailed owing to lack of water. Generally, in other districts, conditions

were fairly favourable and yields proved to be above the average.

High winds, during the months of June, July and August, caused a considerable amount of damage to the more advanced plantations and were responsible to a certain extent for the large percentage of damaged leaf.

Mosaic disease was reported from all districts, and a number of cases assumed epidemic form, necessitating the destruction of several acres of tobacco.

One plantation suffered from a severe attack of Hollow Stalk (*Bacillus carotovorus*), but did not cause much loss as it appeared after harvesting had commenced.

Towards the end of the year, Black Shank disease (*Phytophthora parasitica*) was reported from the majority of plantations, but did not cause much damage as the plantations were too far advanced, harvesting in the majority of cases having commenced.

Crop Returns.—The yields and values of the leaf produced and the quantity of the different grades are dealt with below.

TABLE 2

Acreage Yields

Type.	1933–34. Acres.	1933–34. Yield in kilos.	Kilos. per acre.	1934–35. Acres.	1934–35. Yield in kilos.	Kilos. per acre.	Increase in yield per acre.
							Per cent.
Flue-cured	981	313,680·9	319·7	676	302,377·9	447·3	40
Air-cured	1,100¼	239,541·4	217·8	245	142,720·6	582·5	168
Total .	2,081¼	553,222·3	265·8	921	445,098·5	483·2	82

There was a considerable variation in yields from different estates, the highest yield recorded for flue-curing being 1,114·7 kilos. per acre, and the lowest 215 kilos. per acre; whilst for air-curing the highest was 1,628·7 kilos. per acre and the lowest 100·1 kilos. per acre.

TABLE 3

Acreage Values

Type.	1933–34.	1934–35.	Increase.
			Per cent.
Flue-cured . .	Rs. 506 : 27	Rs. 601 : 69	18·8
Air-cured . .	Rs. 191 : 52	Rs. 490 : 15	155·9

The variation in acreage value was also considerable. For flue-curing the highest recorded was Rs. 1,327 : 81 per acre and the lowest was Rs. 231 : 72 per acre;

whilst for air-curing the highest was Rs. 1,371 : 95 and the lowest was Rs. 62 : 74.

TABLE 4

Average Value of Leaf per Kilo.

Type.	1933–34.	1934–35.	Decrease. Per cent.
Flue-cured . .	Rs. 1 : 58	Rs. 1 : 34	15·1
Air-cured . .	Rs. 0 : 87	Rs. 0 : 84	3·4

During the year under review, the average value per kilo. was affected by the fact that full prices were only paid for a quota of 300 kilos. per acre, leaf produced in excess being purchased at reduced prices, the reduction being $33\frac{1}{3}$ per cent.

The variation in the average value per kilo., for the different estates, was also considerable. For flue-curing the highest recorded was Rs. 1 : 74·9 and the lowest Rs. 0 : 88·8 per kilo; whilst for air-curing the highest was Rs. 1 : 31·3 and the lowest Rs. 0 : 45·2 per kilo.

TABLE 5

Grades of Flue-cured Leaf produced

Grades.	1933–34.		1934–35.	
	Kilos.	*Per cent.*	*Kilos.*	*Per cent.*
Bright . .	9,128·4	2·91	9,671·1	3·10
Medium . .	143,267·3	45·62	103,679·8	34·28
Dark. . .	140,268·3	44·71	145,882·3	48·34
Perished . .	—	—	25,233·6	8·35
Green . .	4,813·3	1·61	8,635·5	2·86
Scrap . .	16,203·6	5·15	9,275·6	3·07
Total .	313,680·9	100·00	302,377·9	100·00

During the year under review, a further series of grades were introduced, i.e. perished grades; prior to the introduction of those grades the majority of perished leaf was included in the damaged grades, but as this type was increased in quantity it was necessary to introduce the special grades.

More than 50 per cent. of the leaf produced was damaged and perished, and whilst high winds contributed to the amount of damaged leaf, the chief causes were the use of a complete fertiliser with too great a percentage of phosphate, which gave rise to premature ripening, allowing leaf to become over-ripe, and careless handling. The quality of leaf produced during the season under review was probably lower than ever before.

TABLE 6

Grades of Air-cured Leaf produced

Grades.	1933-34.		1934-35.	
	Kilos.	*Per cent.*	*Kilos.*	*Per cent.*
Bright	1·2	—	7·0	0·05
Medium	9,932·0	4·16	10,948·5	7·66
Red	128,938·3	53·84	99,163·6	69·47
Dark	63,931·6	26·69	13,863·0	9·71
Green	5,561·1	2·31	3,324·4	2·31
Scrap	31,177·2	13·00	15,414·1	10·80
Total	239,541·4	100·00	142,720·6	100·00

There was further improvement in the quality of air-cured leaf produced ; generally, the leaf was of good body, texture and size, and very gummy.

The following quantities of flue-cured and air-cured leaf were exported to London during the year to test the possibilities of finding an export market.

TABLE 7

Type.	Kilos.	Value.
Flue-cured	6,892	Rs. 15,137 : 21
Air-cured	1,630	Rs. 2,372 : 46
Total	8,522	Rs. 17,509 : 67

Uganda.—The report on experimental work carried out at Bukalasa during the period July to December 1934 records that the collection of tobacco varieties was maintained and selections carried on for resistance to mosaic and leaf crinkle, which were particularly severe at Bukalasa this season. Some very promising Burley leaf was obtained.

A start was made with a tobacco-cotton rotation experiment.

RESINS

Lac

Ceylon.—Brief reference to investigation on lac cultivation was made in the report on the work of the Entomological Division last year (see this BULLETIN, 1934, **32**, 302). The subject is dealt with in greater detail in the report of Mr. F. P. Jepson, Acting Entomologist, for 1934, from which the following particulars are taken.

The desire of the Ministry of Agriculture that lac cultivation, as a peasant industry, should be encouraged in Ceylon has necessitated the subject being considered one of the major activities of the Entomological Division during the year, and it occupied prior place among the

investigations in hand during the latter half of the year. As two distinct varieties of the same species of lac-producing insect (*Laccifer lacca* Kerr) are concerned in this enterprise it will be convenient to consider them under separate headings.

(1) *Kusum* or *Kon lac*.—The host tree of this form of lac is *Schleichera trijuga*, the Ceylon oak, known to the Sinhalese as " kon," to the Tamils as " puvu " or " kula," and as " kusum " in India. Its natural habitat in Ceylon is in the dense forests of the dry zone, the tree being particularly plentiful in the North-central Province, parts of the North-western Province and extreme north of the Central Province. It occurs, however, in other parts of the island, particularly along the banks of rivers, and is to be found as a cultivated tree in many private gardens throughout the island. It produces an edible fruit, stands hard pruning, and will give rise to new shoots after pruning at any time of the year. In these latter respects it is a very suitable host tree for lac insects and produces lac of superior quality which, in Ceylon, commands a higher price than that formed on other host trees.

Laccifer lacca, when established upon kon, undergoes a different life-cycle in India from that which is followed upon other host trees. The normal swarming periods of the insect on most hosts in India are June/July and October/November. On kon, however, they are January/February and June/July. In the absence of any definite information regarding the behaviour of the insect in Ceylon it was necessary to assume that the same procedure would be followed here. Experience gained during the past year has indicated that there may be some variation in the seasons of swarming compared with the Indian seasons, but the year has been, climatically, such an abnormal one that the behaviour of the insect during 1934 must not be taken as a criterion of its probable behaviour in future years. One very important lesson has been learnt, and that is that very frequent examinations of the developing lac are essential in the various centres in order to forecast the probable swarming date in each locality. In illustration of this point it may be mentioned that the insects on masan trees (*Zizyphus jujuba*) in the Southern Province commenced to swarm ten days before they did in the Kandy District, although the brood lac from which these insects developed was inoculated upon the same species of host tree on the same day in these two centres. Again, the swarming of the insects on kon trees in the North-western and Central Provinces was expected to take place during January/February 1935, the first swarm in 1934

having occurred on February 8. In fact, swarming commenced at Maho, Wariyapola and Dambulla on December 13, and not until December 20 at Peradeniya. The necessity for continual inspection of the developing insects is, therefore, very apparent if an entire crop of brood lac is not to be lost owing to premature swarming.

As a period of moderately dry weather is necessary for the successful establishment of the young insects at swarming time it follows, provided the swarming seasons in Ceylon are approximately the same as those in India, that the areas which are climatically best suited to the cultivation of kon lac in Ceylon are those in which moderately fine weather conditions may normally be expected during the January/February and June/July seasons. Very roughly these may be said to lie in that part of the island which is situated to the north and east of a line drawn from Puttalam-Maho-Nalanda-Bibile-Moneragalla-Tangalle or, in other words, the area of the island which does not receive the full benefit of the south-west monsoon.

The possibilities of this vast territory, in the matter of abundance of kon trees, require further investigation, but it is believed that these trees are numerous throughout the region specified.

The kon lac now established in Ceylon has been developed from a consignment of $22\frac{1}{2}$ seers of kon brood and 2 maunds of kon × khair (*Acacia catechu*) brood (211 lb. in all) which arrived in Ceylon from India on February 7. The material was inoculated upon kon trees in the Katugastota area by Mr. W. Molegode, Agricultural Instructor, immediately after arrival and during a period of fine, sunny weather. Swarming commenced during the inoculation process and settlement of the young insects was very good.

Indications of the immediate swarming of the next brood were manifest on the morning of July 9, and the crop, weighing 560 lb., of trimmed brood, was harvested on the same day. The original intention was to place all of this brood upon other kon trees in the Katugastota area, but, as heavy rain would be a normal feature of this season in the Kandy district, it was decided to transfer the bulk of the material to the area immediately to the north of Dambulla, where a large number of suitable kon trees occur alongside the main Dambulla-Trincomalie road and where heavy rain is not to be expected at either of the swarming seasons of this variety of lac insect. A total of 373 lb. of brood material was transferred to this area and inoculation was completed on July 12 upon twenty-four trees, which were marked with numbered metal labels.

The remaining 232 lb. of brood were distributed as

follows: 121 lb. were given to the villagers engaged in lacquer work near Angoda in the Katugastota area. Their work is done almost entirely with lac imported from India and they are much interested in the present venture. Their own kon trees in the area have been inoculated and it is expected that, in the immediate future, all their requirements in the matter of raw material for their industry will be forthcoming from their own trees. Another 50 lb. were given to a landowner near Katugastota who is a manufacturer of sealing-wax and who owns a number of kon trees in his area. At present he manufactures his sealing-wax entirely from imported shellac, but it is anticipated that his requirements should be met locally in the near future. A further 25 lb. were redistributed upon kon trees belonging to small-holders who have helped the Department by offering their trees for the growth of the crop which has recently been harvested. They are anxious to continue the cultivation of lac, for which there is a local demand. An additional 20 lb. of brood material were inoculated upon kon trees at Maho and Wariyapola in the North-western Province. The balance of 16 lb. was retained for inoculation of two kon trees in the Royal Botanic Gardens, Peradeniya, where it could be kept under constant observation and thus enable the probable dates of swarming to be forecast.

Swarming of the insects resulting from these inoculations was expected to take place at any time during January or February 1935, but, as mentioned above, it commenced at Maho, Wariyapola and Dambulla on December 13, 1934.

The total crop of brood harvested at this time in all centres amounted to 837 lb., of which only 392 lb. were produced at Dambulla. This poor yield is attributed, mainly, to the most severe drought experienced in the Dambulla area for more than thirty years, but also to the fact that unpruned trees were utilised, with a consequent lack of suitable young wood upon which better incrustations would have been expected. A further, and unexpected, factor which affected the yield was the removal of the brood material from the trees, prior to swarming, by unknown agents, believed to be monkeys.

The distribution of the December brood was as follows: 376 lb. were inoculated upon twenty-one kon trees in a compact block at Inamaluwa, 16 lb. were placed upon two kon trees in Dambulla, 64 lb. were used to inoculate a large kon tree in the Royal Botanic Gardens, Peradeniya, 36 lb. were distributed on fifteen trees at Maho, Wariyapola and various other centres in the North-western Province,

305 lb. were reinoculated upon kon trees at Angoda, and the balance of 40 lb. on the same trees at Ambatenna.

The total quantity of lac now established on kon trees in the North-western and Central Provinces is 837 lb. Double, or even treble, this quantity of brood lac should be available at the next swarming period, which should be in June or July 1935. At that time, sufficient brood will be retained for propagation purposes and the rest will be distributed among those who are already interested in this enterprise and those whom it is hoped to interest in the near future.

In spite of the extremely unfavourable weather conditions which have been experienced during the year it is considered that a fairly satisfactory beginning has been made in this new venture and, in any event, the experience gained has been most valuable.

It is hoped to secure an area of forest land which contains a number of kon trees in the vicinity of Dambulla to serve as a kon lac breeding station. Until a more suitable area can be found, use has been made, with the approval of the Assistant Government Agent, Matale, of a block of land surrounding the P.W.D. Overseer's quarters at Inamaluwa near the fiftieth mile post on the Kandy to Trincomalie road. About thirty well-grown kon trees occur in this block of land, twenty-one of which now carry brood from the December crop. They have not been pruned and, therefore, do not carry wood of an entirely suitable nature for the purpose in view. The younger branches have been made use of and should yield a good crop in June/July next, when the trees should be fairly heavily pruned for further use in December 1935/February 1936. Trees to accommodate the June/July 1935 crop will be needed and such trees are to be selected and pruned early in 1935.

Trees of suitable size, and in sufficient numbers for this purpose, occur alongside the main road about two miles north of Inamaluwa, and steps have been taken to obtain permission to utilise these trees.

(2) *Ber* or *Masan Lac*.—The host of this form of lac is *Zizyphus jujuba*, usually known as " masan," but in some districts as " mahadebera." The Tamils know it as " ilantai." In India it is termed " ber." Although it is found in many parts of the island it is most plentiful in the dry zones, being suited to poor soil and arid conditions.

The normal swarming seasons of this form of lac in India are June/July and October/November, a habit which it must be assumed will be followed in Ceylon until shown to be otherwise. As in the case of kon lac, the successful

settlement of the young insects upon their feeding-grounds at swarming time is dependent upon periods when abnormal rainfall is not to be expected.

The season of greatest rainfall in the year, in many parts of the island, is during the north-east monsoon, particularly October/November, and all such areas must be regarded as being normally unsuited to masan lac culture. The area in which the rainfall during the north-east monsoon period is less than elsewhere in the island is the Hambantota district in the Southern Province. The average combined rainfall for these two months at Hambantota, for example, is 11·63 in. as compared with 24·01 in. at Jaffna. Furthermore, this district is probably richer in masan trees than any other part of the island, although the particular areas where these trees are most plentiful are not, at present, thickly populated.

Previous consignments of masan brood lac received from India have been liberated in the Kandy area, but the inoculations have proved a failure and no further brood material has been raised from these importations.

A further consignment of two maunds of masan brood lac was ordered from India for delivery in June/July with the intention of again attempting its establishment in the Kandy district. It was decided, however, to cancel these arrangements and to liberate the imported material in the Hambantota district, retaining sufficient brood for use near Kandy where its progress could be conveniently followed and swarming dates forecast with some approximate degree of accuracy.

This consignment left Ranchi, Bihar and Orissa, on June 27, arriving at Peradeniya early on the morning of July 3. One hundred and twelve lb. of material were despatched to the Hambantota district without delay and reached Tissamaharama the same evening. The consignment on departure from Ranchi weighed 159 lb., but weighed only 129 lb. on arrival, the loss in weight during transit being due to drying and breakage. Mr. M. P. D. Pinto of the Entomological Division and Mr. W. P. de Silva of the Controller of Plant Pests' Division took charge of the consignment and inoculated the material upon masan trees in the Tissamaharama, Hambantota, Ambalantota and Bata-ata areas on July 4 and 5. The insects commenced to swarm on July 6, i.e. nine days after leaving Ranchi. In addition to masan as a host plant a small quantity of brood material was placed upon three rain-trees (*Enterolobium saman*), two being at Ambalantota and one at Angulmaduwa near Beliatta.

Unfortunately, several inoculated masan trees situated

in a private compound at Ambalantota which, on account of their recent pruning, possessed an abundance of very suitable young wood, were cut down during the absence of the owner, who had kindly placed them at the disposal of the Department. As these trees were likely to produce heavier incrustation of lacs than others utilised in the district their destruction was most unfortunate.

The development of lac on the inoculated rain-trees at Ambalantota has been very encouraging and demonstrates that the species is a valuable alternative host of this variety of lac. The brittle nature of the branches of this tree does not, however, lend itself to ready manipulation either in inoculation or harvesting, unless heavy pruning of the main branches is first undertaken and only the resulting new growth utilised. In the case of an unpruned tree the insects, naturally, make their way to the extremities of the branches where the youngest wood is to be found, and the risk of the branches snapping beneath the weight of the harvesters is one which needs to be avoided.

In order to be in a position to follow the development of this brood material at accessible points and thus anticipate the possible date of swarming in the Southern Province, it was decided to retain a small quantity (11½ lb.) of brood for local inoculation. Of this quantity 5 lb. were sent to Mr. Molegode at Kurunegala for the inoculation of three trees, 5 lb. were inoculated upon four masan trees at Mahaiyawa, near Kandy, and the remaining 1½ lb. were placed upon masan and dhall (*Cajanus Cajan*) at Peradeniya. A few sticks were also tied to the branches of dadap (*Erythrina lithosperma*), *Gliricidia maculata*, rain-tree (*Enterolobium saman*) and *Hevea brasiliensis* as an experiment. These inoculations were not, however, successful. No reason can be given for the failure on *E. saman*, as settlement on the same host with the same brood material in the Southern Province has been very good. Success on *Hevea*, *Gliricidia* and *Erythrina* was not anticipated, but the small trial was made in view of the vast possibilities which would be presented in the event of one of these trees proving a suitable alternative host. Although swarming was good and settlement appeared to be satisfactory for a period of three weeks, the young insects died later.

The development on masan trees at Peradeniya, Mahaiyawa, near Kandy, and Kurunegala, was good. The possibility of heavy rain occurring during July at the period of swarming had to be considered, and for this reason a masan tree at Peradeniya was covered with a canopy of jute hessian to break the fall of rain until the young

insects had selected, and established themselves upon, the sites which they intended to occupy permanently. This protection, however, proved to be unnecessary, as no rain fell at that time. Settlement on *C. Cajan* was fairly good and the utilisation of this alternative host offers possibilities which should not be lost sight of, not only because it places lac cultivation within the reach of the smallest landowner, but also because it provides a means of carrying over a supply of brood material to the following season in the event of suitable wood on the normal host being unavailable.

Indications of swarming of the next brood of masan lac in the Southern Province became evident on October 17, ten days before the forecast date which, at Peradeniya, proved to be correct, swarming commencing on October 26. The crop gathered weighed only 84 lb. and was reinoculated upon masan and rain-trees at Tissamaharama and Ambalantota, one masan tree at Bata-ata also being used. The crop was much smaller than anticipated. This was attributed to several causes, firstly to the destruction of a number of heavily inoculated trees at Ambalantota, already referred to, secondly to the exceptional drought (the rainfall at Tissamaharama for the months July, August and September was 0·04 in., which fell on one day only), and thirdly to the extensive injury caused by an unknown agency, believed to be a species of lizard which has been observed to frequent the inoculated trees, or possibly a bat.

A small quantity of the original July importation of masan lac was sent to Kurunegala for use on masan trees in that district, a further small quantity being retained at Peradeniya and Kandy for convenience of periodical inspection in order to forecast probable swarming dates. The total crop harvested as a result of the July inoculations in various centres amounted to 185 lb., which is far less than should have been obtained under normal circumstances.

The disposal of the masan brood harvested from the October crop was as follows :

Tissamaharama	(*Zizyphus jujuba*)	6 lb.
do.	(*Enterolobium saman*)	36 lb. 8 oz.
Ambalantota	(*Z. jujuba*)	19 lb.
do.	(*E. saman*)	18 lb. 8 oz.
Bata-ata	(*Z. jujuba*)	2 lb.
Ambalantota	(*Z. jujuba*)	2 lb.
Kandy	(*Z. jujuba*)	8 oz.
Peradeniya	(*Z. jujuba*)	2 lb. 8 oz.
do.	(*E. saman*)	5 lb. 2 oz.
do.	(*Cajanus Cajan*)	1 lb. 6 oz.
Kurunegala	(*Z. jujuba*)	91 lb.
Colombo	(*Z. jujuba*)	8 oz.
	Total	185 lb.

Settlement of the young insects is reported to be satisfactory in all centres. The next crop should be harvested in June–July 1935.

A small area of scrub jungle near Parangam Wewa in the Tissamaharama area has been placed at the disposal of the Department by the Assistant Government Agent, Hambantota. The area contains a number of masan trees which, however, require pruning before they can be made full use of.

(3) *Lac Enemies.*—Damage to the growing lac has been caused by various agents, particularly two species of predaceous moth larvæ, *Eublemma amabilis* Moore (*Noctuidæ*) and *Holococera pulverea* Meyr. (*Blastobasidæ*) and also by three Chalcid parasites, *Tachardiæphagus tachardiæ* How. (*Encyrtidæ*), *Parechthrodryinus clavicornis* Cam. (*Encyrtidæ*) and *Tetrastichus purpureus* Cam. (*Eulophidæ*).

In the case of the injury by moth larvæ, the eggs are laid upon the encrustation and the resulting larvæ work their way into the encrustation which they devour. Both of the above species are formidable enemies of *L. lacca* in India. They are both established in Ceylon, and *Eublemma amabilis* is probably indigenous. The insect collection at Peradeniya contains specimens collected by Mr. E. E. Green, late Entomologist of Ceylon, from lac introduced from India as long ago as 1901, and the insect, if not indigenous, has probably been established in the island for many years.

The Hymenopterous enemies mentioned above are common primary parasites of *L. lacca* in India. Whether they, also, are indigenous to Ceylon, or have been introduced in imported material, cannot be said. In the opinion of the Entomologist to the Indian Lac Research Institute, the actual damage caused to lac by parasites is very small. At the same time their activities cannot be ignored.

Other unexpected enemies are monkeys, at least the removal of brood sticks from inoculated trees is attributed to their agency. They watched the process of affixing the brood sticks to the trees at Dambulla with interest, and the discovery, shortly afterwards, of all sticks from one tree on the ground beneath the tree suggests that curiosity prompted the monkeys to visit the trees and remove the sticks, which had been tied to the branches. Unfortunately, the sticks had been removed before swarming had taken place. Similar mischievous damage by monkeys is reported from India, where scares operated by wind are suggested if the damage is serious.

The most serious damage to local lac has been caused

by an unknown agent which, as mentioned earlier in this report, is believed to be a lizard or a bat. The damage is known to take place at night. The entire lac incrustation is removed from the branches by this enemy and, recently, branches have been found where even the bark beneath the incrustation has been stripped. So far, the damage has been limited to lac growing on masan trees in the Hambantota district. It is doubtful if lac could be successfully grown on this host tree in the Southern Province unless this very serious injury could be prevented. If the damage proves to be due to the agency of lizards or bats its prevention is likely to prove a difficult matter.

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Dried Grapefruit Refuse—a Valuable Feed. By W. M. Neal, R. B. Becker and P. T. Dix Arnold. *Press Bull.* 466, *Florida Agric. Exper. Sta.* Pp. 2, 9 × 6. (Gainesville: University of Florida, 1934.)

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Nederlandsch-Indië als Leverancier op de Wereldmarkt van Vetzaden en Plantaardige Vetten. By P. A. Rowaan. *Ber. No.* 88, *v.d. Afdeel. Handelsmuseum v.d. Kon. Vereen. Kol. Inst.* Pp. 16, 8¼ × 5½. (Amsterdam: Koloniaal Instituut, 1934.) Reprinted from *De Indische Mercuur*, September 26, 1934. Deals with the production of oils and oil seeds in Netherland Indies.

Report and Accounts of the Coconut Research Scheme for 1934. Pp. 11, 9¾ × 6¼. (Colombo: Government Record Office, 1935.) Price 15 cents.

Observations on Rat Damage to Coconuts on Taveuni. By R. W. Paine. *Agric. Journ., Fiji* (1934, **7**, No. 1, 26–34).

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The Oil Palm in Malaya. By B. Bunting, C. D. V. Georgi and J. N. Milsum. *Malayan Planting Manual No.* 1. Pp. 293, 8½ × 5½. (Kuala Lumpur: Department of Agriculture, 1934.) Price 4*s*. 8*d*.

Fuel Economy in the Palm Oil Factory. By C. D. V. Georgi and T. A. Buckley. *Malayan Agric. Journ.* (1935, **23**, 67–75).

Soya Beans and Soya Bean Oil. By F. Turner. *Oil and Colour Trades Journ.* (1935, **87**, 311–314).

Report on the Soap Industry in Ceylon. By R. Child. *Bull. No.* 1, *Coconut Res. Scheme, Ceylon.* Pp. 45, 9¾ × 7¼. (Lunuwila, Ceylon: Coconut Research Scheme, 1934.)

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Essential Oil Plants, their Cultivation and Essential Oils. By E. V. Wulff and V. I. Nilov. Pp. 389, 10 × 6¾. (Leningrad: Lenin Academy of Agricultural Sciences, 1934.) In Russian.

Le Bois de Cèdre. By A. Rolet. *Parfumerie Moderne* (1935, **29**, 63–67). An account of cedar wood and its oil.

Studies in the Control of Spike Disease in Sandal. Use of Plant Poisons in Controlling the Spread of Infection. By A. V. Varadaraja Iyengar. *Indian Forester* (1935, **41**, 103–111).

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The World's Cotton Position. Effect on Empire Cottons. *Trop. Agric., W.I.* (1935, **12**, 104–107).

Annual Report of the Indian Central Cotton Committee, Bombay, for the year ending August 31, 1934. Pp. 152, 9¾ × 7¼. (Bombay: Secretary, Indian Central Cotton Committee, 1935.) Price Rs. 2.

Estimated Production and Distribution of Various Types of Indian Cotton. *Stat. Bull. No.* 3, *Indian Central Cotton Committee*. Pp. 16, $9\frac{1}{2} \times 7\frac{1}{4}$. (Bombay: Secretary, Indian Central Cotton Committee, 1934.) Price Annas 8.

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Some Microbiological Activities affected in Manurial Control of Cotton Root Rot. By C. J. King, C. Hope and E. D. Eaton. *Journ. Agric. Res.* (1934, **49**, 1093–1108).

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Studies in the Wilt Disease of Cotton in the Bombay Presidency. By G. S. Kulkarni. *Indian Journ. Agric. Sci.* (1934, **4**, 976–1048).

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Relative Permanence of Papers Exposed to Sunlight. By G. A. Richter. *Indust. Eng. Chem.* (1935, **27**, 177–185).

A Chemical Investigation of *Pinus radiata* in Relation to its Paper-making Qualities. Part I. The Distribution and Nature of the Non-Volatile Ether Extractives. By W. E. Cohen. *Journ. Counc. Sci. and Indust. Res., Australia* (1935, **8**, 27–36).

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Twenty-Sixth Report of the Council of the Rubber Growers' Association and Statement of Accounts for year ended December 31, 1934. Pp. 51, $9\frac{3}{4} \times 6$. (London: Rubber Growers' Association, 1935.)

Report of the Work of the Rubber Research Board, in 1933. Pp. 65, $9\frac{3}{4} \times 6\frac{1}{4}$. (Ceylon: Rubber Research Scheme, 1935.)

Manganese Salts in Plantation Rubber. By S. A. Sackett. *Indust. Eng. Chem.* (1935, **27**, 172–176). Deals with the use of manganese salts in crude rubber manufacture and their effect.

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The Tobacco Industry in Australia. By R. E. Courthope-Giles. *Journ. Dept. Agric., S. Australia* (1934, **38**, 614, 616).

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Report on the Fermentation Industries for 1934. Prepared for the Society of Chemical Industry and the Institute of Brewing. By R. H. Hopkins and F. W. Norris. Pp. 30, 9¾ × 7½. (London: Institute of Brewing, 1935.)

Preparation of Starch from Indigenous Grains and Tubers. By H. P. Das Gupta and V. Subrahmanyan. *Agric. and Livestock in India* (1934, **4**, 645–654). Deals with the preparation of starch from rice and from the rhizomes of shati (*Curcuma zedoaria* Roscoe).

Livestock and Animal Products

Annual Administration Reports of the Civil Veterinary Department, Bombay Presidency, for the year 1933–34, including the Bombay Veterinary College; the Bombay City and Harbour Veterinary Department and the Civil Veterinary Department in Sind. Pp. 48, 9¾ × 6½. (Bombay: Superintendent, Government Printing and Stationery, 1935.) Price Annas 3 or 4*d*.

Cattle Improvement and Cattle Breeding Policy in Southern Rhodesia. A Review of the General Position Chiefly as Regards Ranching Cattle. By A. E. Romyn. *Rhodesia Agric. Journ.* (1935, **35**, 98–107).

The Inheritance of Productivity in Farm Live Stock. I. Meat. By J. Hammond. II. Milk. By A. D. Buchanan Smith. III. Breeding for Egg Production. By A. W. Greenwood. IV. Wool. By J. E. Nichols. V. Discussion of Preceding Contributions. By J. L. Lush. *Empire Journ. Exper. Agric.* (1935, **3**, 1–30).

The Dairy Industry in Cyprus. Production and Disposal of Dairy Products. By H. Pitcairn. *Cyprus Agric. Journ.* (1934, **29**, 100–106).

Dairy Cattle Breeding in Jamaica. By T. P. Lecky. *Journ. Jamaica Agric. Soc.* (1934, **38**, 686–696; 1935, **39**, 24–29).

Present State of the Dairying Industry in Various Countries. Italy. By E. Gasser. *Inter. Rev. Agric.* (1935, **26**, 197T–210T).

Some Aspects of the International Trade in Butter and Cheese. I. Historical and Statistical Review. II. South Africa as a Dairy Country. By F. R. Tomlinson. *Farming in S. Africa* (1935, **10**, 18–20; 55–56).

Milk Marketing in Denmark. By J. Grant. *Scottish Journ. Agric.* (1935, **18**, 20–33).

Diseases of Sheep. By J. A. Howarth. *Circ.* 86, *California Agric. Exten. Serv.* Pp. 71, 9 × 6. (Berkeley: University of California, 1934.)

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Salmon Canning on the Pacific Coast. Developments in Methods at Famous U.S.A. Canneries. By V. Cahalin. *Food* (1935, **4**, 201–204).

Oysters: Their Life History, Cultivation and Commercial Purification. By E. B. Dewberry. *Food Manufacture* (1935, **10**, 118–122).

A Brief Description of Processes of Making Leather. By W. E. Graham. *Publication of the National Research Council, Canada.* Pp. 59, 11 × 8½. (Ottawa: National Research Council.) Mimeographed copy.

Le Pelli di Capra: Identificazione e Riconoscimento. By B. Cuccodoro. *Boll. uff. R. Staz. Sper. per l'Indust. delle Pelli e delle Materie Concianti* (1935, **13**, 57–67). A study of goat skins.

The Protection of Hides and Skins from the Ravages of the Skin Beetle, *Dermestes vulpinus*. By B. Smit. *Sci. Bull. No.* 129, *Dept. Agric., Union of S. Africa.* Pp. 17, 9 × 6. (Pretoria: Government Printer, 1934.) Price 3*d*.

FORESTRY

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Report of the Director of Forests, Queensland, for the year ended June 30, 1934. Pp. 47, 13 × 8¼. (Brisbane: Government Printer, 1934.)

Annual Report of the Woods and Forests Department, South Australia, for the year ended June 30, 1934. Pp. 12, 13¼ × 8½. (Adelaide: Government Printer, 1934.)

Fifteenth Annual Report of the Forests Commission of Victoria, Australia, 1933–34. Pp. 20, 13 × 8¼. (Melbourne: Government Printer, 1935.) Price 1*s*.

La Question Forestière au Cameroun. By P. Foury. *Actes and Comptes Rendus de l'Assoc. Col. Sci.* (1934, **10**, 65–76; 103–108; 123–132; 175–180; 199–206; 223–229; 1935, **11**, 12–20; 37–42).

Report of the Director of Forestry, Canada, for the year ended March 31, 1934. Pp. 40, 9¾ × 6½. (Ottawa: King's Printer, 1934.)

Report of the Department of Lands and Forests, Nova Scotia, 1934. Pp. 95, 9¾ × 6¼. (Halifax: King's Printer, 1935.)

Report of the Minister of Lands and Forests of the Province of Ontario, for the year ending October 31, 1933. Pp. 140, 9¾ × 6½. (Toronto: King's Printer, 1934.)

Forest Research in India, 1933–34. Part II. Provincial Reports. Pp. 123, 9¾ × 6¼. (Delhi: Manager of Publications, 1935.) Price Rs. 2–6 or 4*s*. 3*d*.

Report of Forest Administration in Baluchistan for the year 1933–34. Pp. 35, 9¾ × 6¼. (Delhi: Manager of Publications, 1935.) Price Rs. 3–14 or 6*s*. 6*d*.

Report on Forest Administration in Burma (excluding the Federated Shan States) for the year ending March 31, 1934. Pp. 295, 9½ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1935.) Price Rs. 3–8 or 5*s*. 3*d*.

Report on Forest Administration in the Utilization Circle, Burma,

for the year ended March 31, 1934. Pp. 81, $9\frac{1}{2} \times 6\frac{1}{4}$. (Rangoon: Superintendent, Government Printing, 1934.) Price Rs. 3 or 4*s.* 6*d.* An appendix contains the Annual Report by the Forest Economist for the same period.

Administration Report on the Forest Department of the Central Provinces for the year ending March 31, 1934. Pp. 23, $9\frac{1}{2} \times 6\frac{1}{4}$. (Nagpur: Government Printing, C.P., 1934.) Price Annas 14.

Report on the Forest Administration of the Central Provinces for the year ending March 31, 1934. Statements. Pp. 52, $9\frac{1}{2} \times 6\frac{1}{4}$. (Nagpur: Government Printing, C.P., 1934.) Price Re. 1–8.

Annual Progress Report of Forest Administration in the United Provinces for the period April 1, 1933, to March 31, 1934. Pp. 83, $9\frac{3}{4} \times 6\frac{1}{2}$. (Allahabad: Superintendent, Printing and Stationery, 1934.) Price Rs. 2–6.

Annual Report on the Forest Department, Mauritius, for the year 1933. Pp. 17, $9\frac{3}{4} \times 6$. (Port Louis: Government Printer, 1934.)

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The Forest Types of Trinidad and their Principal Species. By R. C. Marshall. *Forestry Pamphlet No.* 2, *Forest Dept., Trinidad.* Pp. 16, $8\frac{1}{2} \times 5\frac{1}{2}$. (Port-of-Spain: Government Printer, 1934.) Price 6*d.*

Annual Report of the Department of Forestry, Union of South Africa, for the year ended March 31, 1934. Pp. 45, $13 \times 8\frac{1}{4}$. (Pretoria: Government Printer, 1934.) Price 2*s.* 6*d.*

Topbeschadigingen door Insecten in Boschculturen. By L. G. E. Kalschoven. *Korte Med. No.* 47, *Boschbouwproefsta., Ned.-Ind.* Pp. 20, $9\frac{1}{2} \times 6\frac{1}{4}$. (Buitenzorg: Archipel Drukkerij, 1934.) An account of the insects attacking the tips and young shoots of tree saplings in the Netherland Indies. With English summary. Reprinted from *Tectona* (1934, **27**, 721).

A Phomopsis Disease of Conifers in New Zealand. By T. T. C. Birch. *Bull. No.* 7, *New Zealand State Forest Serv.* Pp. 30, 9×6. (Wellington: Government Printer, 1935.) Price 1*s.* 9*d.*

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Notes on Malayan Timbers. IV. By H. E. Desch. *Malayan Forester* (1935, **4**, 23–29). Deals with the timbers Nemesu (*Shorea pauciflora*) and Damar Lant Merah (*Shorea Kunstleri*).

The Composition of Philippine Woods. VII. By F. M. Yenko, Luz Baens and A. P. West. *Philippine Journ. Sci.* (1934, **55**, 1–11).

A Manual of the Air Seasoning of Indian Timbers. By S. N. Kapur. Pp. 113, $9\frac{3}{4} \times 7\frac{1}{4}$. (Delhi: Manager of Publications, 1934.) Price Rs. 3 or 5*s.* 3*d.*

The Preservation of Timber. *Trade Circ. No.* 27, *Div. Forest Products, Counc. Sci. and Indust. Res., Australia.* Pp. 22, $9\frac{1}{2} \times 6$. (Melbourne: Government Printer, 1934.)

Results of Experiments on the Kiln Drying of Wood with Ozonized Air. By S. N. Kapur. *Indian Forest Records, Econ. Series,* Vol. XX, Pt. XIII. Pp. 20, $9\frac{3}{4} \times 7\frac{1}{2}$. (Delhi: Manager of Publications, 1935.) Price Annas 8 or 10*d.*

Report on the Demand for Timber in Coal-Mining in England and Wales. *Utilization Series No.* 2, *Forestry Commission.* Pp. 77, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1935.) Price 1*s.* 3*d.*

Report of the Forestry Commission on the Demand for Timber for Box and Packing-Case Manufacture in Great Britain. Pp. 47, 9½ × 6. (London: H.M. Stationery Office, 1934.) Price 9*d.*

Gums and Resins

Gums in Pharmacy. I. The Viscous and Plastic Groups. II. The Gelatinous and Glairy Groups. By G. Middleton. *Pharmaceuticals and Cosmetics* (1935, **1**, 10–11; 20, 23).

The Botanical Identity of Jelutong. By C. F. Symington. *Malayan Forester* (1935, **4**, 82–85).

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Shellac. The Lac Industry and the Chemistry of Lac. By A. J. Gibson and A. Karim. *Oil and Colour Trades Journ.* (1935, **87**, 464–470).

Lac and the Indian Lac Research Institute. By D. Norris, P. M. Glover and R. W. Aldis. Pp. 53, 9¾ × 7½. (Namkum, Ranchi, Bihar and Orissa: Indian Lac Research Institute, 1934.) Price Rs. 2–8. Contains a survey of the Indian lac industry, an account of the work of the Indian Lac Research Institute, notes on the outlook for the industry and lac production in Assam and Burma, and a list of publications issued by the Research Institute.

Annual Report of the Indian Lac Research Institute, for the year April 1, 1933, to March 31, 1934. Pp. 35, 9¾ × 7½. (Namkum, Ranchi, Bihar and Orissa: Indian Lac Research Institute, 1934.)

Lac Cultivation in Ceylon. By F. P. Jepson. *Trop. Agric., Ceylon* (1934, **83**, 356–361). An account of recent steps which have been taken by the Department of Agriculture to investigate the possibilities of establishing this new industry.

Stoklac in Nederlandsch-Indië. By A. T. J. Bianchi. *Korte Med. No.* 45, *Boschbouwproefsta., Ned.-Ind.* Pp. 7, 9½ × 6¼. (Buitenzorg: Archipel Drukkerij, 1934.) Deals with the natural occurrence of sticklac in the Netherland Indies; lac cultivation is non-existent in the country. Summary in English. Reprinted from *Tectona* (1934, **27**, 486).

Isolation of Pure Lac Resin. By L. C. Verman and R. Bhattacharya. *Tech. Paper No.* 1, *London Shellac Research Bureau.* Pp. 21, 8½ × 5½. (London: India House, 1934.)

Some Industrial Possibilities of Pure Lac Resin. By L. C. Verman. *Journ. Soc. Chem. Indust.* (1935, **54**, 86T–88T).

Tanning Materials

Report of the Natal Wattle and Timber Growers' Association, for the year 1934. Pp. 6, 13 × 8¼. (Pietermaritzburg: Natal Wattle and Timber Growers' Association, 1935.)

I. Further Experiments on Controlling Wattle Bagworm by Dusting. By L. B. Ripley and B. K. Petty. II. An Inquiry into the Method of Controlling Wattle Bagworm by Salt, as Proposed by Henkel and Bayer. By L. B. Ripley, B. K. Petty and G. A. Hepburn. *Sci. Bull. No.* 131, *Dept. Agric., Union of S. Africa.* Pp. 23, 9 × 6. (Pretoria: Government Printer, 1934.) Price 3*d.*

Tannin Content of Philippine Barks and Woods. By Luz Baens, F. M. Yenko and A. P. West. *Philippine Journ. Sci.* (1934, **55**, 177–190).

Synthetic Tannins. By K. Felzmann. *Journ. Fed. of Curriers, Light Leather Tanners and Dressers, Inc.* (1935, **15**, No. 12, 307–315).

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

LE BANANIER ET SON EXPLOITATION. By D. Kervégant. Pp. viii + 578, 10 × 6½. (Paris: Société d'Editions Géographiques, Maritimes et Coloniales, 1935.)

This is a comprehensive treatise, covering every aspect of its subject, which cannot fail to be of value to all connected in any way with the banana industry.

The first chapter surveys the history of the banana from the Garden of Eden to the United Fruit Company. Following chapters deal in no less detail with the morphology and botany of the plant, its varieties, chemistry, ecology, cultivation, harvesting, pests and diseases. Among these last the Panama disease naturally receives the greatest amount of consideration; its history, causes, incidence and treatment are discussed and the necessity emphasised for the systematic destruction of diseased plants and the quarantine of infected areas. The best method of destroying the plants is still a subject for discussion; pulling up the plants to burn them involves disturbing infected soil, which is undesirable, and the best results so far appear to have been those obtained in Jamaica by applying "heavy gas oil" to the stools and surrounding soil.

Other sections of the book are devoted to various aspects of the banana trade, such as storage, packing, transport, regulated and artificial ripening, the banana as food, and the industrial utilisation of the fruit and its by-products. Among these, perhaps the most interesting chapter is that dealing with the manufacture of dried bananas (banana "figs"). The preservation of fruit and other food products has now reached a high degree of scientific perfection, but dried bananas have failed to become popular, mainly because of the difficulty of presenting them in an attractive form. The special problems involved in the satisfactory preparation of the "figs" are here dealt with critically and constructively, and the information given should be of considerable help to producers wishing to embark on their manufacture. The manufacture and use of banana flour are also fully treated.

There are useful chapters dealing with the development of the industry in individual exporting countries and with

the markets in the principal consuming countries; and finally there is a bibliography of some 700 references.

A History of Food Adulteration and Analysis. By Frederick A. Filby, M.Sc., Ph.D. Pp. 269, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: George Allen & Unwin, Ltd., 1934.) Price 10*s*.

Dr. Bernard Dyer, Past-President of the Society of Public Analysts, contributes a foreword to this volume, in which he says: "This little treatise by Dr. Filby is the result of much patient research in often recondite directions. Dr. Filby has succeeded in unearthing for the information of the general reader much historically interesting matter relating to the sophistication of articles of food, drugs and drink in earlier times and to the efforts made from time to time by corporations and city companies to cope with some of the prevalent evils with which he has dealt in sometimes gruesome detail."

No full account can be given here of the contents of the book, but it may be said that the treatise is both interesting and entertaining, and traces in an illuminating manner the history of food adulteration up to recent times in which such practices have been subjected to increasingly efficient methods of control—with the result that, as the author remarks, "probably, among all the transactions of life there is none in which one can be more sure of the approximate value for money than in the purchase of food."

The Practice and Science of Breadmaking. By D. W. Kent-Jones, Ph.D., B.Sc., F.I.C. Pp. 184, $8\frac{3}{4} \times 5\frac{1}{4}$. (Liverpool: The Northern Publishing Co., Ltd., 1934.) Price 7*s*. 6*d*.

The author of this volume, who is Chief Examiner in Breadmaking to the City and Guilds of London Institute, explains in his Preface that it is the outcome of requests for an elementary book dealing with the practice of breadmaking and also emphasising its scientific aspect; and that his aim has been to satisfy this demand and also to provide a textbook for students. The work is clearly arranged, and attractively printed; the contents cover the principal aspects of breadmaking from the flour and yeast to the finished loaf, and include an illustrated description of baking machinery and ovens, as well as a summary of the legislative requirements to which English bakers have to conform.

The volume should prove very useful to those for whom it is primarily intended, and can also be recommended to

general readers desiring a clear and concise description of the art of commercial breadmaking.

SHELLAC: ITS PRODUCTION, MANUFACTURE, CHEMISTRY, ANALYSIS, COMMERCE AND USES. By Ernest J. Parry, B.Sc. (Lond.), F.I.C., F.C.S. Pp. xi + 240, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Sir Isaac Pitman & Sons, Ltd.) Price 12*s*. 6*d*.

The literature devoted to Indian lac, or shellac, has hitherto been chiefly confined to chapters in general treatises, and to articles disseminated through various official and technical publications, and there has been no book available dealing solely and comprehensively with the subject. The present volume, which supplies this deficiency, is therefore very welcome.

After describing at some length the formation of lac, and the life history of the lac insect, the book continues with an instructive chapter on the practical production of lac. Parasitic, predatory and other indirect insect enemies of the lac insect are also dealt with. Good descriptions are given of the methods of collecting the lac, and of the well-known processes of purification and the manufacture of the commercial product. Two chapters are devoted to the analysis and chemistry of shellac. They contain a useful survey of the investigations which have been carried out during recent years, and include details of the commercial methods employed for the analytical evaluation of lac in its different forms.

Other pages, concerned with the commerce of lac, furnish information regarding the marketing of the product in India, and the regulations and contracts governing transactions in the shellac trade in London. The author enumerates the uses of shellac in various industries, and states that he knows of no synthetic resin "which can seriously compete with shellac with the least chance of supplanting it." The preparation, properties and uses of wax-free and of bleached lac are also described.

There are four appendixes which contain (1) original papers by the author on the analysis of shellac, (2) United States standards and methods of analysis of shellac, (3) a glossary of terms, mostly native, connected with the industry, and (4) a useful bibliography. The book contains a coloured frontispiece of the lac insect, and fifteen other illustrations. As stated in a foreword by Sir Harry Lindsay, this book can be heartily commended to the business man, to the man of science and to the student of economics.

Colloid Chemistry. By Arthur W. Thomas, Professor of Chemistry, Columbia University. Pp. viii + 512, 8 × 5½. (London: The McGraw-Hill Publishing Co., Ltd., 1934.) Price 24s.

In his Preface, the author of this work points out that " treatises on colloid chemistry are based generally upon a physical viewpoint, treating the colloidally dispersed particle as a suspended, insoluble unit providing an interface to which non-colloidal substances may be adsorbed in an empirical manner quite devoid of any relationship with the phenomena of classical chemistry." In view of this, Professor Thomas has treated colloidal dispersions from the point of view of crystalloidal chemistry, " where the particle is regarded, partly at least, as in solution, as the polar groups of water-insoluble organic compounds are dissolved in water with the non-polar parts protruding according to the postulates of Langmuir, and also of Harkins, about seventeen years ago." The merit of the application of the classical viewpoint to protein solutions has been proved by the researches of Pauli, Michaelis, Loeb, Cohn and others.

For inorganic dispersions, " the viewpoint of this book revives the ideas of Linder, Picton and Duclaux, among others, of twenty-five to thirty-five years ago. It is undoubtedly easier to consider inorganic dispersions from a physical angle, but the author feels that such a treatment is inadequate unless supplemented by considerations of the chemical nature of the constituents. The application of the Werner-Pfeiffer concepts of complex compound formation has provided a rational basis for an explanation of the behaviour of these dispersions in some specific instances."

The present book is the outgrowth of the author's courses of lectures on colloid chemistry, and naturally presupposes a familiarity on the part of the reader with elementary inorganic, organic and physical chemistry. The fundamental techniques of colloid chemistry are critically discussed, and a copious bibliography is provided at the end of each chapter for those who desire further details. The writer states that he has endeavoured to assemble interesting facts, even where explanation is lacking, with the hope that workers in applied fields as well as pure science investigators may find the book useful and be informed where the elucidation of colloid problems needs their assistance.

The work is clearly arranged and excellently produced, and forms a valuable addition to the existing literature of colloids.

Dictionary of Terms Relating to Agriculture, Horticulture, Forestry, Cattle Breeding, Dairy Industry and Apiculture, in English, French, German and Dutch. Compiled by T. J. Bezemer. Pp. vii + 1059, 8 × 5¼. (London: George Allen & Unwin, Ltd., 1934.) Price 25*s*.

The publishers of this work call attention in their Preface to the fact that students of the subjects in question are often obliged to consult textbooks or works of reference in foreign languages, and that in searching for translations of the technical terms met with in such literature they find that the ordinary standard dictionaries, if they give the words required at all, fail to provide satisfactory equivalents. This applies also to common words when used with a restricted or specialised meaning. For this reason, Professor Bezemer and other members of the staff of the well-known State Agricultural College at Wageningen, Holland, decided to remedy the deficiency by the publication of the present work.

The dictionary is arranged in four sections, for English, German, Dutch and French respectively, each of which is separately paged and forms a self-contained polyglot dictionary in itself, i.e. each term in the principal language is translated into the other three. The scope of the work may be judged from the fact that the number of terms dealt with in each section is about 10,000. The compiler acknowledges in a Foreword the important help received from a number of expert collaborators, at Wageningen and elsewhere, and says: "This work is the first dictionary of its kind in this field, and it is as such that it should be judged by the users. The great number of auxiliary sciences which have to be studied for the practice of agricultural economy rendered it imperative to make a selection of the words to be included in the work. For instance, not all the names of useful and injurious insects have been included (this subject would require a dictionary of its own), but only those which are most important for agriculture in the widest sense of the term. This work cannot, therefore, precisely because it is the first in the field, make a claim to completeness."

Professor Bezemer adds that he would be grateful if users of the dictionary would send him suggestions with regard either to words which have been omitted or to any equivalents which they may consider to be incorrect. The book needs a modicum of such correction; in addition, a few unimportant mistakes in spelling should be rectified. The work of compilation, however, has been carried out with admirable care and general accuracy and the dic-

tionary should be of great utility to those for whom it is designed. The printing and general arrangements are excellent, and the book will prove a valuable addition to many private and technical libraries.

THE ARACHNIDA. By Theodore H. Savory, M.A. Pp. xi + 218, $9\frac{1}{2} \times 7\frac{1}{2}$. (London: Edward Arnold & Co., 1935.) Price 25*s*.

In his Preface, the author of this work states that his purpose in writing it was "to make a first attempt to give Arachnology something of the unity and status of an individual science that is possessed by Entomology." He adds that "The Insect is not only better advertised by its beauty than is the Arachnid; it also sustains attacks on the bodies, crops and possessions of man with a greater success. The result has long been a natural dominance of Entomology over most other branches of Zoology."

The volume is divided into three Parts, the first of which describes the structure of the Arachnid, its habits, distribution, evolution and classification. Part II considers in detail the various Orders, including fossil forms, whilst Part III is concerned with the science of Arachnology as a whole, with special reference to its economic and practical aspects.

A chapter likely to have special interest for many readers of this BULLETIN is that on Economic Arachnology, which deals principally with Mites, the only Arachnids of marked economic importance to man. Those interested in arachnology in general will appreciate the entire volume, which is admirably produced and illustrated.

THE ELEMENTS OF PRACTICAL FLYING. A DETAILED SURVEY FOR STUDENTS AND AIR PILOTS. By P. W. F. Mills. Pp. vii + 133, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: The Technical Press, Ltd., 1935.) Price 4*s*. 6*d*.

As stated on its dust cover, this book is a thoughtful, concise and informative exposition of the basic theory and practice of flying. Into eight well-written chapters, bearing the rather staccato headings of first principles; stability and control; the speed element; general performance; taking-off; turning; landing, and the personal element, the author has managed to compress a mass of really practical information on flying. Each operation in the control of an aeroplane is fully explained, the explanations being further clarified by useful analogies. The book should be in the hands of every pupil of flying, but should also appeal to all who take an intelligent interest in modern aviation.

BOOKS RECEIVED FOR NOTICE

MANUAL OF THE GRASSES OF THE UNITED STATES. By A. S. Hitchcock. *United States Department of Agriculture, Miscellaneous Publication No.* 200, *February,* 1935. Pp. 1,040, 9 × 6. (Washington: Superintendent of Documents, Government Printing Office, 1935.) Price $1.75.

NOTES SUR LA PREPARATION DU CAFÉ. By A. Ringoet. Pp. 52, $9\frac{3}{4} \times 6\frac{1}{4}$. *Publications de l'Institut National pour l'Étude Agronomique du Congo Belge, Serie Technique No.* 1. (Brussels: L'Institut National pour l'Étude Agronomique de Congo Belge, 1935.) Price 5 francs.

LE PYRÈTHRE. Culture et Utilisation. *Propagande et Vulgarisation agricoles. Série A: Phytotechnie, Tract No.* 1. Pp. 16, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brussels: Direction Générale de l'Agriculture et de l'Élevage, Ministère des Colonies.) Price 1 franc.

LE RICIN. *Propagande et Vulgarisation agricoles. Série A: Phytotechnie, Tract No.* 2. Pp. 32, $8\frac{1}{2} \times 5\frac{1}{2}$. (Brussels: Direction Générale de l'Agriculture et de l'Élevage, Ministère des Colonies.) Price 1 franc.

PROBLEMS IN SOIL MICROBIOLOGY. By D. Ward Cutler and Lettice M. Crump. Pp. vii + 104, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1935.) Price 9*s*.

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION. By Alfred W. Nash, M.Sc., M.I.Mech.E., F.C.S., F.Inst.Fuel, and Donald A. Howes, B.Sc., Ph.D., A.M.I.P.T. Volume II, pp. xiv + 523, $9\frac{3}{4} \times 6$. (London: Chapman & Hall, Ltd., 1935.) Price 30*s*.

CRUSHERS FOR STONE AND ORE. Their Development, Characteristics and Capabilities. By William T. W. Miller, M.Inst.C.E., M.I.Mech.E. Pp. ix + 234, $8\frac{3}{4} \times 6$. (London: Mining Publications, Ltd., 1935.) Price 15*s*.

THE BOOK OF STAINLESS STEELS, CORROSION RESISTING AND HEAT RESISTING CHROMIUM ALLOYS. Edited by Ernest E. Thum. Second edition. Pp. xii + 787, 9 × 6. (Cleveland, Ohio: The American Society for Metals, 1935.) Price $5.

CONTENTS

VOL. XXXIII. NO. 3

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

SOME AFRICAN OIL SEEDS

DURING recent years a number of oil seeds, which are used locally by the natives as sources of oil or fat, have been received at the Imperial Institute from various parts of Africa, the reports on which are printed in the following pages.

PO-YOK FRUITS FROM SIERRA LEONE

The oil of Po-yok or Po-yoak kernels from Sierra Leone was first investigated at the Imperial Institute in 1917 and a report was published in this BULLETIN (1918, **16**, 38). The oil proved to be a drying oil of promising character with properties somewhat similar to those of Tung oil. Since that time further samples of the fruits and kernels have been received for examination at the Imperial Institute and more information regarding the Po-yok tree has become available.

The fruit of the Po-yok tree closely resembles that of certain species of *Parinarium* and, as stated in the report referred to above, the authorities at Kew at first regarded the plant as belonging to that genus. More complete material has since been received and the tree has now been definitely identified as *Afrolicania elæosperma* Milbr. (Nat. Ord. Rosaceæ).

According to Hutchinson and Dalziel (*Flora of West Tropical Africa*, Vol. I, Part 2, 1928, p. 316), *A. elæosperma* is common at Grand Bassa, Liberia, and occurs at Eket in the Southern Provinces, Nigeria, and in the French Cameroons. In addition, the tree is found in Bonthe

CONSTANTS OF PO-YOK OIL

	1	2	3	4	5	6	7
Specific gravity at 15/15° C.	0·9556	0·9535	0·9612	0·9654	0·9642	0·9690	0·963
Refractive index, 40° C.	1·5020	1·5024	1·5082	1·5109	1·5110	—	—
Acid value	16·3	19·3	6·0	0·4	0·6	17·4	2·6
Saponification value	191·9	189·9	188·0	189·2	190·6	192·3	189·1
Iodine value (Wijs, 3 hrs.) *per cent.*	139·9	143·1	149·9	150·9	150·5	157·1 [1]	156·9 [1]
Unsaponifiable matter *per cent.*	0·7	1·0	0·9	0·3	0·4	0·7	0·8
Solidifying points of fatty acids, ° C.	30·0	50·3	39·1	46·9	47·2	48·3	30·6
Heat test at 300° C.	No gelation took place in these four samples on heating for 30 minutes.				Jelly formed after 16 minutes.	Jelly formed after 20 minutes.	No gelation after more than 10 minutes' heating at 280° C.
Iodine test [2]	No gelation took place in these five samples even on standing for 20 hours or more.					Jelly formed in a few minutes.	—

[1] *Hübl, 17 hrs.*

[2] *In the iodine test 1 cc. of the oil is dissolved in 5 cc. of chloroform, 5 cc. of a saturated solution of iodine in chloroform are added, and the whole well agitated; the mixture is then left to stand.*

1. Fruits picked up on the beach.
2. Dried kernels separated in Sierra Leone from the fruits (1).
3. Dried kernels of fruits picked fresh from the trees.
4. Fresh fruits.
5. Fruits older than (4).
6. Fruits.
7. Oil prepared in Sierra Leone.

Island, Sierra Leone, and may possibly occur in other places along the south coast of that Colony. Mr. F. C. Deighton, Mycologist to the Department of Agriculture, Sierra Leone, in a report on Po-yok furnished to the Imperial Institute, states that there are probably not many more than one hundred of the trees on Bonthe Island. The following particulars regarding the tree and the local uses of the oil are taken from Mr. Deighton's report.

The growth of the tree is slow. Seedlings at Yoni, Bonthe Island, at least five years old, were only 8 ft. high and showed no signs of fruiting. Trees at least twenty years old had only grown to 20 ft. in height. Mature trees do not always bear fruit each year, but it is estimated that a good tree should give half a bushel of fruit per annum. The total quantity of fruit available each year in Bonthe Island cannot, therefore, be much more than 50 bushels.

Po-yok fruits are grey and warty on the outside. Their shape is ovoid, the length being about 4 cm. and the greatest width from 2·75 to 3 cm. The shell of the fruit is thin (1 mm.) and easily cracked, and is covered with a tough outer layer (1 mm. in thickness) which decays fairly readily when the fruit is on the ground. The fruit contains a large, very oily kernel, with a somewhat disagreeable and distinctive odour.

Po-yok oil is used by Bundu women either mixed with white clay and put on the body as a scent or used alone as hair oil. For the preparation of the oil the fruits are dried over a fire or preferably in the sun. This process shrinks the kernels and facilitates the cracking of the shell, which is effected by beating with sticks. The kernels are then heated and pounded in a mortar, the resulting mass being subsequently boiled with water and the oil skimmed off the surface.

The results of the examination at the Imperial Institute of several samples of Po-yok fruits and kernels from Bonthe Island are given in the following table; the constants of their oils, together with the results obtained for a sample of Po-yok oil prepared in Sierra Leone in 1917 (*loc. cit.*) are shown in the table opposite.

COMPOSITION OF PO-YOK FRUITS

Samples:	1	2	3	4	5	6
Average weight of a fruit, in grams	7·3	—	—	11·8	9·5	11·3
Average weight of a kernel, in grams	5·0	6·4	4·6	7·2	5·9	6·3
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Shell in fruits	31·4	—	—	39·0	38·5	44·0
Kernels in fruits	68·6	—	—	61·0	61·5	56·0
Moisture in kernels	6·8	6·8	9·0	5·9	6·0	8·7
Oil, in kernels as received	57·5	56·2	41·7	55·3	54·9	58·3
Oil, expressed on moisture-free kernels	61·7	60·3	45·8	58·8	58·4	63·8
Oil, expressed on fruits as received	39·4	—	—	33·7	33·8	32·6

Sample 1. Fruits picked up on the beach.
Sample 2. Dried kernels separated in Sierra Leone from the fruits (1).
Sample 3. Dried kernels of fruits picked fresh from the trees.
Sample 4. Fresh fruits.
Sample 5. Fruits older than (4).
Sample 6. Fruits.

Po-yok oil is viscous and golden-yellow, with an odour resembling that of Tung oil. On standing it deposits stearin. The high iodine value of Po-yok oil indicates that the oil belongs to the class of drying oils, and it has been found to have marked drying properties when exposed to air and light, the film formed being tough and not transparent. In the case of two samples the oil was found to form a gel when heated for 16 to 20 minutes at 300° C., and in this respect resembles Tung oil, but this property is not possessed by every sample of Po-yok oil. The reason for this variation has not yet been determined.

Po-yok oil could be utilised as a drying oil in the manufacture of paints and varnishes, but technical trials would be necessary to determine its precise value. The limited number of trees known to exist in Sierra Leone, however, rules out the possibility of obtaining commercial supplies of the fruit from that country. Moreover, the prospects of increasing supplies by cultivation are not encouraging in view of the slow growth of the tree and its irregular fruiting.

Balanites ægyptiaca Fruits from Uganda

A report on the fruits, kernels and oil of *Balanites ægyptiaca* from Northern Nigeria, the Sudan and Uganda

was published in this BULLETIN (1908, 6, 364). The sample of fruits now dealt with was forwarded by the Director of Agriculture, Uganda, in July 1933. They were stated to have been obtained from the Madi area of the Gulu District.

B. ægyptiaca Del. (Nat. Ord. Simarubaceæ) is a tree reaching a height of 20 to 30 ft. It has a wide distribution in the drier regions of West Africa and the Sudan, extending southwards into Uganda and Tanganyika and eastwards into Palestine and Arabia. In Uganda the tree is known as "Lugba," in Northern Nigeria as "Betu" and in the Sudan as "Heglig."

The sample consisted of ovoid fruits which had a thin, friable outer skin varying in colour from golden-yellow to reddish-brown. This skin covered a layer of half-dried sticky pulp, which surrounded a hard fibrous shell about 0·1 in. in thickness; the whole forming 87·3 per cent. of the weight of the fruits. The shell enclosed a single, pale yellow, fairly hard kernel. In most cases the fruits were partly or completely free from the outer friable skin.

The fruits varied considerably in size, ranging from $\frac{3}{4}$ to $1\frac{7}{8}$ in. in length and from $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter. The corresponding dimensions of the kernels were from $\frac{1}{2}$ to $1\frac{1}{4}$ in. in length and about $\frac{3}{8}$ in. in diameter.

The fruits averaged 5·7 grams and the kernels 0·7 grams in weight.

The kernels were found to contain 6·4 per cent. of moisture, and on extraction with light petroleum yielded 46·8 per cent. of a golden-yellow liquid oil, equivalent to 50 per cent. calculated on the moisture-free kernels, or 5·9 per cent. on the entire fruits.

The oil, which had a nutty odour, deposited a small amount of stearin on standing.

The meal left after the extraction of the oil from the kernels with light petroleum was pale lemon-coloured and possessed a bitter unpleasant taste. It contained a principle giving with the usual alkaloidal reagents faint positive reactions, which, however, were not typical of alkaloids. When shaken up with water the meal yielded a strong, persistent froth, indicating the presence of a saponin.

The constants of the oil and the composition of the meal are shown in the following tables:

CONSTANTS OF *BALANITES ÆGYPTIACA* OIL

—	Present Sample.	Previous Samples from Northern Nigeria.	Previous Samples from Sudan.
Specific gravity at 15/15° C.	0·9220	0·919	0·9187
Refractive index at 40° C.	1·4640	—	—
Acid value	0·9	5·0	1·4
Saponification value	191·6	196·7	194·2
Iodine value (Wijs, 3 hrs.) *per cent.*	98·0	—	—
,, ,, (Hübl, 17 hrs.) *per cent.*	—	92·5	98·2
Unsaponifiable matter *per cent.*	0·3	0·6	—
Solidifying point of fatty acids	36·0° C.	34·6° C.	34·0° C.

COMPOSITION OF *B. ÆGYPTIACA* MEAL

	Meal as prepared. *Per cent.*	Calculated for meal containing 7 per cent. of fat. *Per cent.*
Moisture	8·9	8·3
Crude proteins	48·8	45·7
Fat	0·6	7·0
Carbohydrates, etc. (by difference)	30·3	28·3
Crude fibre	5·9	5·5
Ash	5·5	5·2
Nutrient ratio	1 : 0·65	1 : 0·97
Food units	154	160

It would not be remunerative to export Lugba fruits from Uganda, as the outer pulpy layer and shell, which form the greater part of the weight, would be of no commercial interest in the United Kingdom. It is, moreover, very doubtful whether the kernels could be profitably extracted in a fit condition for shipment, as the pulpy layer of the fruits makes the cracking of the enclosed shell very difficult and would therefore have to be removed (probably by fermentation) before the shells were cracked. Further, the shells themselves are fibrous and do not break very easily, whilst the kernels, though fairly hard, are readily broken, so that when freed from the shell they would be largely in fragments and would probably be greatly damaged during transit. The kernels, if in good condition, would only be worth about £8 per ton in the United Kingdom (December 1933), and to obtain a ton it would be necessary to treat 8 tons of fruit.

The oil could be employed for soap-making, but it should also be suitable for edible use, and for this latter purpose would be worth about £19 per ton in the United Kingdom. In view, however, of the difficulty of extracting the kernels, it is unlikely that it would pay to prepare the oil in Uganda for shipment.

The residual meal is rich in protein, but its bitter taste and the presence of a saponin would preclude its use as a feeding-stuff for animals, and it could only be employed as a fertiliser, for which purpose it would probably be worth about £4 per ton in the United Kingdom.

Ximenia americana Fruits from South Africa

The fruits of *Ximenia americana* Linn., which are the subject of this report, were forwarded to the Imperial Institute by the Principal Botanist, Department of Agriculture, Union of South Africa, in August 1934. They had been received through the Extension Officer at Ixopo from a local resident, and it was desired to ascertain whether the fruits, which are produced prolifically by plants growing on very poor dry land, would be of value as a source of oil and feeding-cake.

A brief account of the tree and the local uses of the fruit, which is sometimes known as "Wild Olive," was given in the report on an earlier sample from South Africa, published in this Bulletin (1917, **15**, 313).

The fruits of the present sample were dark reddish-brown and measured from 0·7 to 1·0 in. in length and from 0·5 to 0·7 in. in diameter. They consisted of: (1) an outer layer of dark reddish-brown pulp, (2) a thin, brittle shell, and (3) a soft, cream-coloured kernel. The average weight of the fruits was 2·2 grams and that of the kernels 1·3 grams.

They were found to consist of pulp and shell 41·2 per cent., and kernel 58·8 per cent. The kernels contained 5·1 per cent. of moisture, and, on extraction with light petroleum, yielded 60·6 per cent. of oil, equivalent to 63·9 per cent. in the moisture-free kernels and 35·6 per cent. in the fruits as received.

The oil, as extracted with light petroleum, was

brownish-yellow, cloudy and very viscous, and did not become clear on heating. It was found to have the following constants, which are shown in comparison with those obtained at the Imperial Institute for the oil of *Ximenia americana* from the 1917 sample of kernels referred to above, and from another sample received from South Africa in 1924.

—	Present Sample.	Samples of *X. americana*. 1917.	1924.
Specific gravity at 15/15° C.	0·9362	0·9221	0·9234
Refractive index at 40° C.	1·4700	—	—
Acid value	2·6	2·1	1·0
Saponification value	169·7	170·4	170·7
Iodine value (Wijs, 3 hrs.) *per cent.*	93·7	—	—
,, ,, (Hübl, 17 hrs.) *per cent.*	—	93·6	94·8
Unsaponifiable matter *per cent.*	2·4	2·9	3·1

The unsaponifiable matter consisted in each case mainly of a rubber-like substance.

The residual meal left after the extraction of the kernels with light petroleum was cream-coloured and tasteless at first, but possessed an unpleasant after-taste. The meal was analysed with the following results, which are shown in comparison with those obtained for the residual meals of the previous samples of *X. americana* kernels:

—	Present Sample.	Previous Samples. 1917.	1924.
	Per cent.	*Per cent.*	*Per cent.*
Moisture	10·6	6·2	7·5
Crude proteins	44·6	38·8	41·3
Oil	1·9	5·3	1·6
Carbohydrates, etc. (by difference)	33·0	38·1	38·0
Crude fibre	5·2	6·3	6·1
Ash	4·7	5·3	5·5
Nutrient ratio	1 : 0·8	1 : 1·3	1 : 1·0
Food units	149	148	145

The meal was found to be free from cyanogenetic glucosides.

By calculation from the above results the present kernels had the following composition :

	Per cent.
Moisture	5·1
Crude proteins	17·5
Oil	60·6
Carbohydrates, etc. (by difference)	13·0
Crude fibre	2·0
Ash	1·8
Nutrient ratio	1 : 8·7
Food units	208

The Ximenia oil obtained from the kernels by extraction with light petroleum contains an appreciable amount of rubber-like unsaponifiable matter which would be prejudicial to its utilisation for industrial purposes. Trials were accordingly made to determine whether this objectionable constituent could be eliminated, either wholly or in part, by adopting other methods of preparation, e.g., by expressing the oil from the kernels or by the use of some other solvent.

Experiments carried out with a laboratory press indicated, however, that the oil, owing to its viscous character, could not be successfully prepared by pressing the kernels, thus confirming the conclusions of previous investigators that the oil would have to be obtained by solvent extraction.

In the course of the earlier investigations of *X. americana* kernels at the Imperial Institute it had been found that by employing acetone as a solvent it was possible to extract an oil which was less viscous than that prepared by means of light petroleum, and a trial with this solvent was therefore made in the present case. The oil thus extracted was pale yellow and slightly cloudy, but the cloudiness disappeared on warming. Its viscosity was much less than that of the oil extracted by light petroleum. It was found to have the following constants, which are shown in comparison with those obtained for the oil extracted by light petroleum :

		Extracted with acetone.	Extracted with light petroleum.
Specific gravity at 15/15° C.		0·9227	0·9362
Refractive index at 40° C.		1·4688	1·4700
Acid value		0·7	2·6
Saponification value		173·4	169·7
Iodine value (Wijs, 3 hrs.)	*per cent.*	94·9	93·7
Unsaponifiable matter	*per cent.*	0·6	2·4

From these figures it will be seen that the amount of unsaponifiable matter in the acetone-extracted oil was much less than in that extracted with light petroleum. Moreover, the former oil contained very little, if any, of the rubber-like constituent.

The present fruits were similar in appearance to the samples of *X. americana* fruits from South Africa previously examined at the Imperial Institute. The kernels contained a large percentage of oil, and the constants of the oil extracted with light petroleum were very similar to those previously recorded, the only noteworthy difference being in the higher specific gravity. The composition of the residual meal was also similar to that from the previous samples of kernels.

As already mentioned, it seems unlikely that the oil could be prepared by pressing the kernels, and solvent extraction would be necessary. The oil obtained in the present case by extraction with light petroleum resembled the earlier samples in being viscous and cloudy, and in containing an appreciable quantity of a rubber-like constituent, the presence of which would account for the high viscosity of the oil. Such oil could not be used for edible purposes and would probably prove unattractive for the manufacture of soap in competition with other readily available oils. Its comparatively low iodine value indicates that it would be unsuitable for use in paint- and varnish-making.

The acetone-extracted oil, on the other hand, proved to be practically free from the objectionable rubber-like substance. It might, therefore, prove more suitable for soap-making, and possibly, after refining, for edible use. The value of such oil would, however, be only about £13 to £14 per ton in the United Kingdom (November 1934).

The residual meal is rich in proteins, but feeding trials carried out in Germany on several kinds of animals with the residual meal of *X. americana* kernels are stated (*Der Pflanzer*, 1911, **7**, 486) to have shown that the meal is not well suited for use as a feeding-stuff. The present meal would probably give similar results, but feeding trials would be necessary to determine this point. In this connection it may be pointed out that the meal left after

extraction with acetone would contain most of the rubber-like constituent of the kernels, and this might affect its suitability for use as a feeding-stuff.

Owing to the inferior quality of Ximenia kernels in comparison with other oil seeds, and in view of the current over-production of vegetable oils generally and the consequent low price of these commodities, it does not appear likely that under existing conditions it would be profitable to exploit Ximenia kernels as a source of oil, except possibly for local markets.

It may be mentioned in connection with any attempt to utilise Ximenia oil in South Africa, that the kernels can be readily extracted from the dry fruits by treatment in a Miller's palm-nut cracking machine, and subsequent separation by means of sieves and an air-blast, such as are employed in machines used in the preparation of palm kernels.

Sterculia fœtida Seeds from the Gold Coast

Sterculia fœtida Linn. (Nat. Ord. Sterculiaceæ) is a large evergreen tree with a wide distribution in the tropics of the Old World, extending from West and East Africa to India, Ceylon, the Malay Archipelago and Northern Australia. The seeds are used by the natives almost throughout this region as a source of oil.

In 1912 a sample stated to be the " fruits " of *Sterculia fœtida* was sent from Ceylon, to the Imperial Institute for examination, and in the report published in " Selected Reports from the Scientific and Technical Department, Imperial Institute, Part V—Oil Seeds, Oils, Fats and Waxes," issued as *Colonial Reports—Miscellaneous No.* 88, 1914, p. 495, they were treated as such. It was subsequently found, however, that the so-called " fruits " really consisted of seeds, which are unusual in possessing a three-layered seed coat, and this fact seems to have been the cause of the original mistake. The description of the sample as given in that report, therefore, requires amendment and should be read in conjunction with that given below of a further sample of the seeds, which was received from the Director of Agriculture, Gold Coast, in January 1933.

The seeds from the Gold Coast were ovoid and measured about 1 in. in length and ½ in. in diameter. The average weight of a seed was 2 grams. Their composition was as follows:

	Per cent.
Seed Coat:	
1. Outer layer—grey, thin and papery	3·6
2. Middle layer—pinkish-brown and pulpy	16·2
3. Inner layer—very dark reddish-brown and horny	26·2
Kernel:	
Soft and cream-coloured	54·0

Both the middle layer of the seed coat and the kernel contained oil, the total yield, expressed on the entire seeds, being 34·2 per cent.

Middle layer of seed coat.—This was found to contain 7·9 per cent. of moisture and 43·2 per cent. of oil, or 46·9 per cent. expressed on the moisture-free material.

The oil, as extracted with light petroleum, was a pale greenish-yellow liquid which deposited a considerable quantity of stearins on standing. It was examined with the following results:

Specific gravity at 100/15° C.		0·8652
Refractive index at 40° C.		1·4615
Acid value		4·5
Saponification value		198·1
Iodine value (Wijs, 3 hrs.)	*per cent.*	84·5
Unsaponifiable matter	*per cent.*	0·7

Kernel.—This contained 6·0 per cent. of moisture and 50·4 per cent. of oil, or 53·6 per cent. expressed on the moisture-free material.

The kernel oil, as extracted with light petroleum, was a pale greenish-yellow liquid. It deposited a slight amount of stearins on standing. It was examined with the following results, which are shown in comparison with figures previously recorded for the kernel oil of *Sterculia fœtida*:

		Present Sample.	Recorded Figures.
Specific gravity at 15/15° C.		0·9281	0·9264
Refractive index at 40° C.		1·4650	1·4658
Acid value		0·6	2·0
Saponification value		191·1	193·8
Iodine value (Wijs, 3 hrs.)	*per cent.*	83·6	75·8
Unsaponifiable matter	*per cent.*	0·6	—
Solidifying point of fatty acids		30·8° C.	—

The constants of the present kernel oil were thus in general agreement with the earlier results quoted.

It is of interest to note that the oil content of the middle layer of the seed coat in the present investigation was much higher than the figures previously recorded (9 to 20 per cent.), whilst that of the kernel agreed with earlier results.

In common with previous samples of the oil from *Sterculia fœtida* seeds, both the present oils gave positive reactions on the application of Halphen's colour test; the kernel oil gave a much more intense colour, which developed rapidly.

The oil from the middle layer of the seed coat, when maintained at 245° C. for 15 minutes, failed to polymerise, and did not polymerise even when the temperature was raised to 290° C., although under this treatment the oil thickened somewhat and darkened in colour.

When the kernel oil was maintained at 245° C. it polymerised in 6½ minutes. The resulting gel was sticky and less firm than the gel prepared from Tung oil.

The residual meal left after the extraction of the oil with light petroleum from the middle layer of the seed coat was pinkish-brown and possessed practically no taste. The meal left after the extraction of the oil from the kernel, on the other hand, was creamy-white and possessed a very slight sweetish taste. The two meals were analysed with the following results:

	Meal from middle layer of seed coat.	Kernel meal.
	Per cent.	*Per cent.*
Moisture	11·9	9·9
Crude proteins	9·5	31·7
Fat	4·4	7·2
Carbohydrates, etc. (by difference)	49·3	43·5 [1]
Crude fibre	21·6	2·6
Ash	3·3	5·1
Nutrient ratio	1 : 6·3	1 : 1·9
Food units	84	141

[1] *The kernel meal contained starch, but the meal from the middle layer of the seed coat did not.*

These results show that the meal from the middle layer of the seed coat would be only of moderate value as a

feeding-stuff, whereas the kernel meal has a good protein content and a high feeding value. It is unlikely, however, that in working on a commercial scale the kernel meal could be obtained free from the horny inner layer of the seed coat, and the large percentage of indigestible fibre present in the latter would preclude the use of such material as a feeding-stuff for animals.

Owing to the structure of *S. fœtida* seeds it is improbable that the middle layer of the seed coat and kernel could be effectively separated and the two different oils expressed from them. Further, the kernel can only be removed with difficulty from the seed coat. If, therefore, the seeds were exploited on a commercial scale as an oil seed, two courses would be open for consideration, viz.: (*a*) the whole seeds might be crushed, when the resulting oil would be a mixture of middle seed coat and kernel oils, or (*b*) the seeds might be piled in heaps and the two outer layers of the seed coat allowed to rot away by fermentation. In the latter case, only the kernel oil would eventually be obtained on crushing and the yield of oil would be correspondingly less. In either case the oil cake obtained would only be suitable for use as a fertiliser.

Whichever course were adopted the resulting oil would be quite suitable for the manufacture of soap, and might possibly be utilised as an edible oil, but it would only realise about £18 to £19 per ton in London (May 1933). The whole seeds should thus be worth about £6 per ton, and the seeds freed from the two outer layers of seed coat about the same.

In view of the prevailing low price of all oil seeds and the presence on the market of adequate supplies of products of better quality, it does not appear likely that under present conditions it would be remunerative to ship *Sterculia fœtida* seeds from the Gold Coast.

Lophira alata Fruits from Uganda

A sample of the fruits of *Lophira alata* Banks (Nat. Ord. Ochnaceæ) was forwarded by the Director of Agriculture, Uganda, in July 1933. They were stated to have been obtained from the Madi area of the Gulu District, where they are called "Liku." Previous samples

examined at the Imperial Institute include kernels from Sierra Leone, where they are known as "Niam" or "Meni" (this BULLETIN, 1908, **6**, 243; 1912, **10**, 226), and oil from the Sudan, where it is known as "Zawa" (*loc. cit.*, 1908, **6**, 366).

The type species has a wide distribution in tropical West Africa from Senegal to the Cameroons and Gaboon, extending into Uganda and the Eastern Sudan. It is characteristic of the savanna forest and forms a small, straggling much-branched tree. It is represented in the heavy-rain forests of West Africa by the var. *procera*, which reaches a height of over 160 ft. with a girth of 15 to 20 ft. at breast height. This variety yields the timber known in the trade as "Ekki."

The present sample from Uganda consisted of fruits which closely resembled those of *L. alata* previously received at the Imperial Institute. They varied from $\frac{3}{4}$ to 1 in. in length and from $\frac{3}{8}$ to $\frac{1}{2}$ in. in diameter. The sample was in good condition, but in many cases the remains of sepals and stalk were attached to the rounded ends of the fruits.

The fruits had a pale cinnamon-brown fibrous shell about $\frac{1}{20}$ in. in thickness, forming 44·9 per cent. of their weight and enclosing a single kernel. The kernels were $\frac{1}{2}$ to $\frac{3}{4}$ in. long and about $\frac{3}{8}$ in. in diameter; their substance ranged in colour from pale buff to dark reddish-brown and varied in hardness according to the colour; i.e. the lighter the colour of the kernel, the softer the texture.

The fruits averaged 0·76 gram and the kernels 0·42 gram in weight.

The kernels were found to contain 12·7 per cent. of moisture, and on extraction with light petroleum yielded 36·9 per cent. of a pale yellow semi-solid fat, equivalent to 42·3 per cent. calculated on the moisture-free kernels or 20·3 per cent. on the entire fruits.

The fat, which was free from any marked unpleasant taste or odour, was found to have the following constants, which are shown in comparison with the corresponding figures obtained for samples of *Lophira alata* fat previously examined at the Imperial Institute.

—	Present Sample.	Previous Samples from : Sierra Leone.	Sudan.
Specific gravity at 100/15° C.	0·8604	0·859	—
,, ,, at 40/40° C.	—	0·9016–0·9105	0·9063
Melting point (by open-tube method)	24·5° C.	—	—
Refractive index at 40° C.	1·4610	—	—
Acid value	7·0	18·54–48·0	5·78
Saponification value	187·9	180·7–195·6	190·1
Iodine value (Wijs, 3 hrs.) *per cent.*	73·2	—	—
,, ,, (Hübl, 17 hrs.) *per cent.*	—	68·0–72·5	78·12
Unsaponifiable matter *per cent.*	1·3	0·5–2·5	1·38
Solidifying point of fatty acids	43·8° C.	45·0°–49·0° C.	42·5° C.

The meal left after the extraction of the oil from the kernels with light petroleum was pinkish-brown, possessed a strong, bitter taste, and contained 5·34 per cent. of nitrogen. It gave with the usual alkaloidal reagents faint positive reactions, but these were not typical of alkaloids. On shaking with water it gave a fairly persistent froth, pointing to the presence of a saponin.

These " Liku " fruits would not be worth shipment as such to the United Kingdom, as they contain about 45 per cent. of shell, which would largely increase the cost of freight while having no market value. It was considered that, under the conditions existing at the date of the report (December 1933), the kernels should be saleable in the United Kingdom as an oil seed at about £5 or £6 per ton ; they would have to be thoroughly dried before being bagged for shipment, so as to prevent an undue increase in the acidity of the oil.

The oil would be suitable for soap-making and for this purpose would be worth about £15 per ton on the United Kingdom market. If it were found possible to refine the oil after importation sufficiently to render it suitable for edible purposes the prices of the crude oil might be increased by about £2 per ton.

On account of its strong bitter taste and the presence of a saponin the residual meal would be unsuitable as a feeding-stuff for animals, and could only be employed as a fertiliser, for which purpose it would probably be worth about £4 per ton in the United Kingdom.

Ochna pulchra Fruits from South Africa

The sample of *Ochna pulchra* fruits which is the subject of this report was forwarded to the Imperial Institute by the Principal Botanist, Department of Agriculture, in February 1935. It consisted of small kidney-shaped fruits from 0·3 to 0·5 in. long and 0·25 to 0·4 in. broad, composed of: (*a*) a thin, soft, oily pericarp, varying in colour from yellowish-brown to black and having a strong unpleasant odour resembling that of valeric acid; (*b*) a thin, brittle, woody shell, almost black in colour; and (*c*) a kernel, varying in colour from greenish-yellow to dark reddish-brown and covered with a tough, straw-coloured, parchment-like seed coat. The average weight of a single fruit was 0·34 gram.

The examination at the Imperial Institute of a sample of *Ochna pulchra* fruits received from Rhodesia in 1924 indicated that in the event of the fruits being employed commercially it would not be practicable to treat the pericarp and kernel separately as sources of oil (see this Bulletin, 1925, **23**, 1). It was therefore decided in the present instance to examine the whole fruits, and the following results were obtained:

	Present Sample. *Per cent.*	Previous Sample from Rhodesia. *Per cent.*
Moisture	12·3	7·7
Oil in the fruits as received	25·9	33·0
,, ,, ,, moisture-free fruits	29·5	35·7

The oil obtained by extracting the present fruits with light petroleum was greenish-brown, and deposited a large amount of stearin on standing. It had an odour resembling that of valeric acid. On examination it was found to have the following constants, which are shown in comparison with those obtained in 1924 for the pericarp oil and kernel oil prepared from the *O. pulchra* fruits from Rhodesia:

—	Present Sample. Oil from whole fruits.	Previous Sample from Rhodesia.	
		Pericarp Oil.	Kernel Oil.
Specific gravity at 100°/15° C.	0·8606	0·8611	0·8615
Refractive index at 40° C.	1·459	1·459	1·460
Acid value	18·2	16·3	21·5
Saponification value	196·8	197·7	197·1
Iodine value . . . *per cent.*	66·7[1]	58·5[2]	74·3[2]
Unsaponifiable matter . *per cent.*	1·2	—	—
Solidifying point of fatty acids	43·4° C.	—	—

[1] *Wijs, 3 hrs.* [2] *Hübl, 17 hrs.*

The residual meal left after the extraction of the whole fruits with light petroleum was pale brown and possessed an odour resembling that of the oil. It was analysed with the following results, which are shown in comparison with the calculated composition of the residual meal from the previous sample of whole fruits :

—	Present Sample.		Previous Sample from Rhodesia. Calculated to contain 7 per cent. of fat.
	As prepared.	Calculated to contain 7 per cent. of fat.	
	Per cent.	*Per cent.*	*Per cent.*
Moisture	11·7	11·0	9·6
Crude proteins	14·5	13·6	12·5
Fat	0·9	7·0	7·0
Carbohydrates, etc. (by difference)	59·4	55·7	57·8
Crude fibre	11·4	10·7	10·9
Ash	2·1	2·0	2·2
Nutrient ratio	1 : 4·2	1 : 5·3	1 : 5·9
Food units	98	107	107

No alkaloids were found either in the present meal or in the meal from the Rhodesian fruits previously examined.

The results of examination showed that the present *Ochna pulchra* fruits did not contain so much oil as those previously received from Rhodesia, but that the oils and residual meals from the two samples were of similar composition.

The oil from the whole fruits was dark in colour and had an unpleasant odour. Without making refining tests, it is not possible to state whether an oil suitable for edible purposes could be prepared from it, but in the unrefined state it could be used for soap-making, and for this purpose should be currently worth about £18 per ton in London (May 1935).

The residual meal from the whole fruits was also of unattractive odour, and contained a rather small percentage of proteins. No alkaloids were found to be present, but on the other hand *Ochna pulchra* fruits are stated to be poisonous, and it would therefore be necessary to carry out practical trials with the meal before a definite opinion could be expressed as to its suitability or otherwise for feeding to stock. Even if the meal is found harmless for this purpose it could probably not be readily disposed

of in the United Kingdom, and in any case would not be worth more than £4 per ton in London at the present time.

As an oil seed these *Ochna pulchra* fruits are not an attractive proposition. In view of their unpleasant odour and moderate oil content, and the large supplies of better oil seeds available, it is very doubtful if oil-seed crushers in the United Kingdom would display any interest in them. Even if saleable the fruits would not realise over £5 per ton in London at the present time, assuming that the residual oil cake could be sold at £4 per ton as a feeding-stuff. If the cake could not be used for feeding to animals, the fruits would only be worth from £3 to £4 per ton.

In these circumstances it is very doubtful whether the fruits could be remuneratively shipped to the United Kingdom, but if they occur in large quantities they might perhaps be used in South Africa as a source of oil, and if practical trials showed that the residual cake left after the expression of the oil had no harmful effects on animals it could be employed locally as a feeding-stuff, preferably in conjunction with other materials.

A summary of the above results, with a description and illustration of the tree, has been published by Dr. E. P. Phillips in *Farming in South Africa*, August 1935, p. 337.

Lulu (Shea) Kernels and Butter from the Sudan

Lulu is the Sudanese name for *Butyrospermum Parkii* Kotschy, the kernels of which are better known in this country as Shea nuts. Samples of the kernels and of fat (butter) prepared from them in the Sudan were forwarded by the Director, Commercial Intelligence Branch, Central Economic Board, Khartoum, in August 1930. They were stated to have been obtained from the Kajo Kaji and Moru districts of Mongalla Province. A report on earlier samples of these products received from the Sudan was published in this Bulletin (1908, **6**, 372). Reference might also be made to the results of examination of a large series of samples of Shea nuts from Nigeria and the Gold Coast, which have appeared more recently (1930, **28**, 123 ; 1931, **29**, 407 ; 1932, **30**, 282 ; 1933, **31**, 334).

The samples received from the Sudan were as follows :

Kernels.—This sample consisted of Lulu (Shea) kernels of normal appearance. They measured from ¾ to 1¼ in. in length and from ½ to ¾ in. in diameter, being mostly 1 in. in length and ⅝ in. in diameter. They were reddish-brown externally and pinkish-brown within. The sample had been slightly attacked by insects.

Butter.—This was received in three tins, the contents of which varied somewhat in consistency. In view of this the contents of the three tins were mixed together at the Imperial Institute. The butter was a brown, semi-solid product, of pasty consistency and possessing a burnt odour. Filtration through paper at 100° C. only slightly improved the colour.

The kernels were found to contain 4·5 per cent. of moisture and to yield on extraction with light petroleum 54·2 per cent. of fat, equivalent to a yield of 56·8 per cent. on the moisture-free kernels. The "Shea butter" thus obtained was a soft cream-coloured fat.

The Lulu butter from the Sudan, after filtration, and that extracted from the kernels at the Imperial Institute, were examined with the results shown in the following table, to which are added for comparison the corresponding figures obtained at the Imperial Institute for previous samples of Sudan Lulu fat, and those recorded for commercial Shea butter:

—	Present Samples of Lulu (Shea) butter.		Sudan Samples examined at the Imperial Institute in 1907–8.		Recorded figures for Commercial Shea butter.
	Prepared in Sudan.	Extracted from kernels at Imperial Institute.	(1)	(2)	
Specific gravity at 100/15° C.	0·8631	0·8592	—	0·8594	—
Melting point (by open-tube method)	25·2° C.	29·3° C.	—	—	29°–32° C.
Refractive index at 40° C.	1·462	1·461	—	—	1·4629 to 1·4656
Acid value	10·4	15·4	10·7	—	4 to 20
Saponification value	184·6	187·0	184·6	184·0	178 to 190
Iodine value (Wijs, 3 hrs.), *per cent.*	64·7	62·8	56·0 [1]	62·9 [1]	57 to 67
Unsaponifiable matter, *per cent.*	3·0	2·6	—	4·3	5 to 11
Solidifying point of fatty acids	52·5° C.	53·0° C.	51·8° C.	—	53·5° C.

[1] *Hübl, 17 hrs.*

These results show that the butter prepared in the Sudan and at the Imperial Institute had constants generally similar to those previously recorded, except that the butter prepared in the Sudan, which was of rather softer consistency than is usual for Shea butter, had a somewhat low melting-point. The percentages of unsaponifiable matter in the samples were lower than those usually present in the fat of Shea kernels from West Africa.

The meal left after the extraction of the kernels with light petroleum was pinkish-brown and had a bitter, astringent taste. On shaking it with water a fairly persistent froth was produced, indicating the presence of a saponin. Tannin was also found to be present. The meal was analysed with the results given in the following table, which are shown in comparison with typical figures previously recorded for Shea meal and cake :

—	Meal from Present Kernels.		Recorded figures for :		
	As prepared.	Calculated for meal containing 7 per cent. of fat.	Shea meal. (1)	Shea meal. (2)	Shea cake.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	13·1	12·6	9·76	12·70	9·95
Crude proteins	15·6	15·0	12·39	12·37	12·13
Fat	3·2	7·0	2·93	4·73	6·50
Carbohydrates, etc. (by difference)	56·8	54·5	61·30	57·67	60·74
Crude fibre	5·4	5·2	7·46	6·48	4·78
Ash	5·9	5·7	6·16	6·05	5·90
Nutrient ratio	1 : 4·1	1 : 4·7	1 : 5·5	1 : 5·5	1 : 6·2
Food units	104	110	100	100	107

From these figures it will be seen that the present sample of residual meal contained slightly more protein than is usually found in Shea meal and cake. Shea meal possesses a bitter, astringent taste, and contains saponin and tannin, but it can be employed in a small proportion (5 per cent.) in the manufacture of compound feeding cakes, for which purpose it would realise from £3 to £5 per ton in London (December 1930).

The Lulu kernels represented by the present sample would be saleable in the United Kingdom if offered in

commercial quantities at a price comparable with that of Shea nuts from West Africa.

On account of its dark colour and burnt taste it is doubtful whether native-made butter of the quality of the present sample would find a ready market. Consignments of suitably prepared butter should be saleable under normal conditions in the United Kingdom, but it would be preferable to ship the well-prepared kernels, which would find a readier market.

Salvadora persica Fruits from the Sudan

A sample of the fruits of *Salvadora persica* Linn. was forwarded by the Director of the Department of Economics and Trade, Sudan, in June 1935. It was desired to ascertain the composition of the fruits, and to learn whether they would find a market in the United Kingdom.

The sample consisted of small, wrinkled fruits, varying in colour from pale brown to dark chocolate brown. The fruits were composed of a pulpy layer surrounding the single seed. The seed had a thin shell, which was greyish-brown to reddish-brown in colour, and a bright yellow kernel. The weight of 100 fruits was 7 grams.

The fruits were composed of pulp 61·2 per cent., and seed 38·8 per cent. The fruits contained 12·3 per cent. of moisture and 13·3 per cent. of oil, equivalent to 15·2 per cent. of oil expressed on the moisture-free fruits, or 34·3 per cent. on the seeds.

The oil as extracted from the fruits with light petroleum was a hard, bright yellow fat, with a slight, not unpleasant odour and a taste which was free from objectionable features. The oil-free meal left after the extraction of the oil had a slightly sweet and somewhat pungent taste.

The oil was found to have the constants shown in the following table, to which are added for comparison the corresponding figures obtained for the oil from a previous sample of *S. persica* seed from the Sudan examined at the Imperial Institute (this Bulletin, 1913, **11**, 61). This earlier sample consisted of seeds from which the pulpy layer had been removed, hence the oil then examined was from seeds only, as compared with oil from the entire fruits in the case of the present material :

		Oil from present sample of fruits.	Oil from previous sample of seeds.
Specific gravity at 100/15° C.		0·8669	0·867
Refractive index at 40° C.		1·4500	—
Melting point (by open-tube method)		34·8° C.	38·0° C.
Acid value		1·3	9·3
Saponification value		247·5	245·2
Iodine value	*per cent.*	7·6 [1]	5·9 [2]
Unsaponifiable matter	*per cent.*	0·9	—
Solidifying point of fatty acids		28·8° C.	30·4° C.

[1] *Wijs*, 3 *hrs.* [2] *Hübl*, 17 *hrs.*

It will be observed that the two oils had similar constants, showing that *S. persica* oil has the same character whether it is extracted from the seeds or from the entire fruits.

After refining, the extracted oil of *S. persica* seeds should be suitable for edible use, but for this purpose it would have to compete with existing commercial supplies of coconut oil, palm kernel oil, hardened oils, etc. In its crude condition it would have a value about equivalent to that of palm kernel oil, viz. about £19 per ton in London at the present time (August 1935).

Owing to their low oil content, the entire fruits would not be of interest to crushers in the United Kingdom. If a simple and efficient method of removing the pulp were found, the seeds might be saleable, but on the basis of the above value for the oil they would not realise more than £6 per ton in London, or possibly £8 per ton if the oil-free residual meal or cake proved to be suitable for use as a feeding-stuff.

The amount of oil extracted from this sample of *Salvadora persica* fruits represents a yield of 34·3 per cent. from the seeds, whereas the previous sample of the seed from the Sudan gave a much higher yield, viz. 44·6 per cent.

In view of the present state of the oil-seed market and the large number of oils and fats now available, it seems doubtful whether the exploitation of *S. persica* seeds in the Sudan for shipment would prove to be remunerative.

AFRICAN BEESWAX

As was pointed out in the article on "The Production of Beeswax in the Empire," published in this BULLETIN (1935, **33**, 49), the United Kingdom is dependent very largely on foreign countries for its supplies of that commodity. In recent years efforts have been made in several of the tropical African possessions not only to increase the supplies but also to improve the quality of the product. In the latter connection samples of beeswax from the Gambia, Tanganyika and Kenya have been sent to the Imperial Institute in order to determine the quality and market possibilities of the material. The results of their examination are given in the following pages.

GAMBIA

Report No. 1

Prior to the outbreak of war in 1914, the Colony of the Gambia was a regular, though not important, exporter of beeswax, the quantity shipped in 1913 amounting to 281 cwts. Exports fell to 30 cwts. by 1920, and subsequently the melting of beeswax was declared to be an obnoxious trade by the Public Health Department and the trade came to a standstill.

In 1929, however, through the activities of the Governor, Sir Edward Denham, K.B.E., C.M.G., attempts were made to revise the industry. A small shipment was made in 1929 (58 cwts.) and since then the exports have been as follows:

	Cwts.
1930	108
1931	102
1932	368
1933	98
1934	534

Every assistance is being rendered by the Department of Agriculture in developing the industry, and the people in the Protectorate are being encouraged to collect the wax, which is sent to a factory at Bathurst for refining. The Director of Agriculture reported in 1930 that he had visited the factory from time to time and that there were

none of the offensive odours coming from it of which the Public Health Department had to complain previously.

A sample of the wax produced in 1929 was supplied to the Imperial Institute for examination. It consisted of three circular slabs, in clean condition and varying in colour from yellowish-brown to brown.

The wax as received was examined with the following results :

	Per cent.
Loss on heating at 105° C.	nil
Ash	0·06
Matter soluble in boiling water	0·12
Dirt	0·10

After being filtered at 100° C. through paper the wax was found to have the following constants, which are shown in comparison with the ranges of corresponding figures for samples of beeswax from East and West Africa :

—	Present Sample.	Samples from :		
		East Africa.	Nigeria.	Sierra Leone.
Specific gravity at 15°/15° C.	0·966	0·949 to 0·965	—	—
Melting point (by open-tube method)	65·0° C.	62·2° to 64·5° C.	63° to 65° C.	63° to 65° C.
Acid value (a)	19·2	17·3 to 21·6	15·6 to 20	18·5 to 20
Saponification value (b)	97·3	84·3 to 102·4	—	—
Ester value ($b-a$)	78·1	66·2 to 80·8	75·3 to 78·4	72·3 to 76
Ratio number $\left(\frac{b-a}{a}\right)$	4·07	3·6 to 4·2	3·7 to 5	3·7 to 4
Iodine value . *per cent.*	10·7	6·1 to 10	5·9 to 9·5	—
Hydrocarbons (by Buisine's method) . *per cent.*	12·4	—	—	—
Salamon and Seaber's test	59·5° C.	60° to 61° C.	—	60·5° C.
Weinwurm's test	Solution slightly opalescent	—	—	—

These results show that the present sample was of normal composition and had the usual characters of African beeswax.

The beeswax was submitted to (*a*) manufacturers and (*b*) brokers in London, who furnished the following observations respectively.

(*a*) " We duly received your sample of Gambia beeswax, which we find to be pure and unadulterated. Provided the wax is supplied exactly as the sample, free from dross and impurities, its value to-day would be £120 per ton, delivered net weights, bags free, c.i.f. London/Liverpool (February 1930). The market has, however, declined steadily owing to the supply being considerably in excess of the demand. It is therefore uncertain whether as much as £120 per ton could be realised to-day.

" We are importing beeswax regularly, and if you can put us in touch with the actual producers or shippers, we would endeavour to place some of our orders with them."

(*b*) " There is a very poor demand for this article at present and also rather heavy stocks, so that for the time being we should not recommend consignments. The value to-day would be roughly 120*s*. per cwt. ex-wharf London, less 2½ per cent. and 1 per cent. (March 1930).

" We trust this information will be what you require, and should the shippers think of consigning to London, we shall be glad to take charge of same, but as previously mentioned we would not recommend a shipment at present, until we see signs of an improvement."

It was pointed out to the authorities in the Gambia that, in view of the good quality of this beeswax, consignments should be saleable in the United Kingdom in competition with supplies from other sources, but the trade reports indicated that the market at that time was overstocked and unfavourable for the ready disposal of consignments.

Report No. 2

In 1935 a consignment of twelve 1-cwt. blocks of beeswax, gathered by natives of the Gambia and clarified under the supervision of the Agricultural Department, was sent to the United Kingdom for sale. A sample taken from one of the blocks was examined at the Imperial Institute with the following results, which are shown in comparison with those obtained for the sample forwarded in 1929.

The following figures were obtained with the wax as received :

	Present Sample. *Per cent.*	Previous Sample. *Per cent.*
Loss at 105° C.	0·1	nil
Ash	0·04	0·06
Matter soluble in boiling water	0·3	0·12
Dirt	0·2	0·10

After filtration through paper, the wax was found to have the following constants :

		Present Sample.	Previous Sample.
Specific gravity at 15°/15° C.		0·9651	0·966
Melting point (by open-tube method)		64·0	65·0
Refractive index at 40° C.		1·4551	—
Acid value		17·2	19·2
Saponification value		96·0	97·3
Ester value		78·8	78·1
Ratio number		4·6	4·07
Iodine value (Wijs, 3 hrs.)	*per cent.*	10·5	10·7
Hydrocarbons	*per cent.*	11·9	12·4
Salamon and Seaber's test		58·6° C.	59·5° C.

The following tests were also carried out on the filtered wax in order to determine the presence or otherwise of certain specific impurities :

Weinwurm's test for the presence of paraffin wax and ceresin	Negative result
Test for the presence of stearic acid	,, ,,
British Pharmacopœia method for the detection of the presence of fats, Japan wax, fatty acids and resin	,, ,,

The results of the examination showed that the sample consisted of clean unadulterated beeswax of normal composition. It closely resembled the previous sample from the Gambia, which was regarded in the trade as quite suitable for the market.

Tanganyika

The production of beeswax is already an established industry in this Territory, the exports in recent years having been as follows :

	cwts.
1930	3,770
1931	12,140
1932	7,820
1933	13,600
1934	8,140

Recently the Entomologist to the Department of Agriculture, in consultation with the Imperial Institute and firms of importers in London, has taken up the question of improving the quality of the wax produced. One of his main objects is to set up a standard below which exporters will be discouraged from shipping wax, and in time actual grading may be introduced. By this means it is hoped to enhance the reputation of the Tanganyika beeswax on the home markets.

In order to demonstrate that material of good quality can be obtained from the ordinary crude wax collected in the Territory a bulk sample of about 50 lb. of clarified wax was prepared by the Entomologist in 1933 from a sack of wax purchased in the Tabora bazaar. This sample was forwarded to the Imperial Institute for examination.

It consisted of a slab of wax measuring 24 × 18 × 3½ in. The colour was yellowish-brown at the top, gradually changing to brown at the bottom of the slab. The fracture was granular. The wax was clean and possessed the normal taste and odour.

The wax was examined with the following results:

	Per cent.
Loss at 105° C.	0·31
Ash	0·06
Matter soluble in boiling water	0·14
Dirt	0·16

After filtration through paper at 100° C. the wax was found to have the following constants, which are shown in comparison with the range of figures previously recorded for East African beeswax:

		Present Sample.	Recorded Figures.
Specific gravity at 15°/15°C.		0·9609	0·9489–0·9650
Melting point (by open-tube method)		62·3° C.	62·2°–64·5° C.
Acid value		19·1	17·3–21·6
Saponification value		94·4	84·3–102·4
Ester value		75·3	66·2–80·8
Ratio number		3·9	3·6–4·2
Iodine value (Wijs, 3 hrs.)	*per cent.*	15·7	6·1–10·0
Hydrocarbons	*per cent.*	13·6	—
Salamon and Seaber's test		57·4° C.	60°–61° C.

Tests were made for the presence of fatty oils, free

stearic acid, paraffin wax and ceresin, and resin, with negative results in each case.

With the exception of the iodine value and the temperature of clouding (Salamon and Seaber's test), the analytical figures for the present sample fall within the ranges recorded for East African beeswax. No great significance, however, is attached to the iodine value of beeswax, and the lower figure observed for the clouding test is not of importance. This test is made to detect the presence of paraffin wax, the addition of which to beeswax raises the temperature of clouding. The usual clouding temperature for pure East African beeswax and beeswax of the European type is about 60° C., whilst for waxes of the East Indian type it is 56° C.

The results of the examination showed that the sample was of good quality and free from adulteration.

The wax was inspected by a firm of importers who considered it to be of good quality. They made an offer to purchase a small consignment of similar material at current prices, if supplies are available in commercial quantities.

Kenya

As in the case of most of the tropical African colonies, there is a native industry in the collection of beeswax in Kenya. The exports in recent years are shown below :

	cwts.
1929	499
1930	433
1931	1,130
1932	1,050
1933	954
1934	1,809

A sample of beeswax, prepared from the ordinary native supplies of the Colony by a special process of cleaning and bleaching, devised by a planter, was received from the Director of Agriculture in January 1934. It was stated that certain firms in London to whom the wax had been offered had expressed a suspicion that it was adulterated. The planter was confident that no adulteration had occurred during the refining process, and it was

desired to have it analysed in order to decide whether any previous adulteration might have taken place.

The sample consisted of a slab of pale straw-coloured, partly bleached wax, of satisfactory hardness. It was found to be free from moisture and insoluble impurities, and to yield only 0·09 per cent. of matter soluble in water and 0·10 per cent. of ash.

After being filtered through paper at 100° C. the wax was examined with the following results, which are shown in comparison with the corresponding figures obtained at the Imperial Institute for a sample of beeswax from Tanganyika examined in 1933 (see p. 298) and with figures previously recorded for East African beeswax :

	Present Sample.	Sample from Tanganyika.	Recorded figures for East African beeswax.
Specific gravity at 15°/15° C.	0·9707	0·9609	0·9489 to 0·9650
Melting point (by open-tube method)	63·6° C.	62·3° C.	62·2° to 64·5° C.
Refractive index at 40° C.[1]	1·4550	—	—
Acid value	13·1	19·1	17·3 to 21·6
Saponification value	100·2	94·4	84·34 to 102·4
Ester value	87·1	75·3	66·2 to 80·8
Ratio number	6·6	3·9	3·6 to 4·2
Iodine value (Wijs, 3 hrs.), *per cent.*	7·9	15·7	6·1 to 10·0
Hydrocarbons *per cent.*	11·4[2]	13·6	—
Salamon and Seaber's test	57·1° C.	57·4° C.	60° to 61° C.

[1] *The refractive index of genuine beeswaxes falls between* 1·4543 *and* 1·4562 ; *being in the majority of samples between* 1·4552 *and* 1·4559 (*Allen,* "*Commercial Organic Analysis,*" *Vol. ii,* 1924, *p.* 327).

[2] *Genuine beeswaxes* (*presumably commercial samples*) *have been found to contain from* 11·0 *to* 17·5 *per cent. of hydrocarbons* (*Allen, loc. cit., p.* 339). *Roberts and Islip found in genuine Indian waxes* 6·9 *to* 12·9 *per cent.* ("*Analyst,*" 1922, **47**, 246).

In order to determine whether any specific materials had been added to the wax, the following tests, among others, were made: (*a*) Weinwurm's test for the presence of paraffin wax and ceresin ; (*b*) test for the presence of stearic acid ; (*c*) method of the British Pharmacopœia (1932) for the detection of fats, fatty acids, Japan wax and resin. In each case a negative result was obtained.

The results of examination show that the analytical figures for the present sample are in agreement with

those previously recorded for East African beeswax, with the exception of the specific gravity, acid value, ester value and ratio number. The specific gravity is above the maximum figure recorded. The acid value is lower than the minimum, and the effect of this low acidity is to raise the ester value and ratio number above the recorded maxima.

It is noteworthy that the tests for purity made at the Imperial Institute failed to indicate any sophistication of the wax, no indication being found of the presence of any foreign material such as paraffin wax, ceresin or carnauba, whilst tests for the presence of fatty oils, fats or fatty acids (such as castor oil, Japan wax or stearic acid) also gave negative results. According to Allen (*loc. cit.*, p. 323) the usual bleaching processes for beeswax do not have the effect of raising the specific gravity or lowering the acid value. It may thus be concluded that the abnormal figures obtained with the sample were due either to the character of the original untreated wax or to the method of cleaning and bleaching employed.

In order to clear up this question it was suggested that a sample of the original wax, together with a sample of the refined product prepared from it, should be submitted to the Imperial Institute for examination. Two samples were accordingly forwarded by the Director of Agriculture in May 1934. They were as follows :

A. Original Wax.—Fairly hard, yellowish-brown wax, slightly dirty externally.

B. Refined Wax.—Pale straw-coloured wax, partly bleached and of satisfactory hardness. The material closely resembled in appearance the sample of refined wax previously submitted.

After being filtered through paper at 100° C. the two samples were examined with the results shown in the following table, which also includes for comparison the corresponding figures obtained for the earlier sample from Kenya, for a sample from Tanganyika examined in 1933, and with figures previously recorded for East African beeswax :

	Present Samples from Kenya. 112—A (Unrefined).	Present Samples from Kenya. 112—B (Refined).	Previous Sample from Kenya. (Refined).	Sample from Tanganyika.	Recorded figures for East African beeswax.
Specific gravity at 15°/15° C.[1]	0·9671	0·9674	0·9707	0·9609	0·9489 to 0·9650
Melting point (by open-tube method)	63·7° C.	63·4° C.	63·6° C.	62·3° C.	62·2° to 64·5° C.
Refractive index at 40° C.[2]	1·4546	1·4554	1·4550	—	—
Acid value	19·8	20·2	13·1	19·1	17·3 to 21·6
Saponification value	95·7	95·4	100·2	94·4	84·34 to 102·4
Ester value	75·9	75·2	87·1	75·3	66·2 to 80·8
Ratio number	3·8	3·7	6·6	3·9	3·6 to 4·2
Iodine value (Wijs, 3 hrs.) *per cent.*	10·1	8·3	7·9	15·7	6·1 to 10·0
Hydrocarbons[3] *per cent.*	11·8	11·3	11·4	13·6	—
Salamon and Seaber's test	58·0° C.	57·4° C.	57·1° C.	57·4° C.	60° to 61° C.

[1] *Allen ("Commercial Organic Analysis," Vol. ii,* 1924, *p.* 330) *records the specific gravity of yellow beeswax at* 15°/15° *C. as* 0·959 *to* 0·970 *and that of bleached wax as* 0·966 *to* 0·968.

[2] *The refractive index of genuine beeswaxes falls between* 1·4543 *and* 1·4562, *being in the majority of samples between* 1·4552 *and* 1·4559 (*Allen, loc. cit., p.* 327).

[3] *Genuine beeswaxes (presumably commercial samples) have been found to contain from* 11·0 *to* 17·5 *per cent. of hydrocarbons* (*Allen, loc. cit., p.* 339). *Roberts and Islip found in genuine Indian waxes* 6·9 *to* 12·9 *per cent.* ("*Analyst,*" 1922, **47**, 246).

The following tests were also made to determine whether the specific materials mentioned had been added to the wax: (*a*) Weinwurm's test for the presence of paraffin wax and ceresin; (*b*) test for the presence of stearic acid; (*c*) method of the British Pharmacopœia (1932) for the detection of fats, fatty acids, Japan wax and resin. In each case a negative result was obtained with both the original and the refined wax.

The foregoing results show that these samples of crude and refined beeswax had closely similar constants and that they both possessed the normal composition of East African beeswax. The characters of the wax had not been materially altered in the course of the refining process, and the refined wax would appear to be quite suitable for sale in the United Kingdom market, although it would not fetch as much as the ordinary bleached wax of commerce on account of its inferior colour.

The sample of refined wax previously examined at the Imperial Institute differed from ordinary East African beeswax in several respects, and it would appear from the

results now recorded that the original wax from which this earlier material was prepared was itself of abnormal character.

A NEW GUTTA FROM SOUTH AFRICA

Early this year samples of the bark, twigs and leaves of *Gymnosporia acuminata* Szyzs. (= *Celastrus acuminatus* Linn.), collected in Swaziland by the Chief Agricultural Officer, were forwarded to the Imperial Institute by the Principal Botanist, Department of Agriculture, Union of South Africa. It had been observed that the plant contained fine silky filaments, and it was desired to ascertain whether the substance of which they were composed was likely to be of commercial interest.

Gymnosporia acuminata is a shrub or small tree seldom reaching more that 20 ft. in height. According to Sims (*Forests and Forest Flora of Cape Colony*) the plant occurs throughout the forest and scrub districts of the Cape, from the coast up to 6,000 ft.; in some mountain patches, as at Cathcart and on the Drakensberg, it is one of the most abundant species. It is also found in Natal, the Transvaal and the Orange Free State. A long list of stations from which it has been recorded is given by Miss J. D. Davidson, in her paper on the Celastraceæ in *Bothalia*, Vol. II, Part 1b, 1927, p. 312.

The material received was in two portions, consisting of (1) bark, and (2) twigs and leaves.

No. 1. *Bark.*—This sample consisted mostly of irregular fragments of bark, up to 6 in. in length and 1½ in. in breadth and about ½ in. thick. Externally the material was generally pinkish to dark reddish-brown; internally it was somewhat paler. Many of the fragments were covered with what appeared to be a brittle, nodular, greyish incrustation. Although of fibrous appearance, the bark was rather brittle and possessed a short fracture. On breaking it and drawing the portions apart, fine filaments of a rubber-like substance were disclosed at the line of fracture.

No. 2. *Twigs and Leaves.*—This sample consisted of leaves and dried, branched twigs, up to 20 in. in length

and varying from about 0·05 to 0·3 in. in diameter. The colour of the twigs was similar to that of the above sample of bark, but was generally obscured by a fine grey incrustation. At the ends of the twigs and loose in the sample were small, oval leaves, about ½ to 1 in. in length and ½ to ¾ in. in breadth, and varying in colour from dark olive-green to brown. On fracture both leaves and twigs exhibited rubber-like filaments.

Representative portions of each sample were first ground in a power-driven disintegrator, no difficulty being experienced in carrying out this operation. The ground material was then extracted with acetone in a Soxhlet apparatus, and the marc, after the removal of the residual acetone by evaporation, was further extracted with benzene. The following results were obtained :

	Sample No. 1.		Sample No. 2.	
	Original ground material.	Calculated on moisture-free material.	Original ground material.	Calculated on moisture-free material.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	10·8	—	10·8	—
Material extracted by acetone:	19·1	21·4	12·5	14·0
Consisting of:				
Extract soluble in water	16·3	18·3	7·8	8·7
Extract insoluble in water	2·8	3·1	4·7	5·3
Material extracted by benzene	10·5	11·8	3·5	3·9

Aqueous solutions of the water-soluble portions of the acetone extracts of both samples gave positive results when treated with Collins' gelatin reagent, and these portions thus evidently contained appreciable amounts of tannin. The water-insoluble portions, after drying, were fairly hard and friable, that from the bark being dark reddish-brown, and that from the twigs and leaves dark greenish-brown. The dried materials were no longer completely soluble in acetone, and were only partially soluble in chloroform.

The benzene extract of the bark (No. 1) was very pale brown or dark cream in colour, and almost entirely soluble in benzene. In order to remove any resins which might not have been removed by the acetone but were still present in the material, fine shreds of it were treated with boiling alcohol under a reflux condenser: the residual

material, which was unchanged in appearance, was found to be no longer readily soluble in benzene, though it swelled up in this solvent. The material was fairly hard and had the general appearance of raw rubber, but it lacked the elasticity of rubber. When boiled with water it softened and became plastic, becoming fairly hard again on cooling. When burnt, an odour resembling that of burning rubber was emitted. After vulcanisation a buff-coloured, very tough and somewhat elastic product was obtained.

The benzene extract of the twigs and leaves (No. 2) was similar to that obtained from the bark, except that it was pale greenish in colour (owing probably to the presence of chlorophyll), and was no longer readily soluble in benzene. Like the benzene extract of the bark, it swelled up in benzene after treatment with boiling alcohol. No vulcanisation trial was carried out on this material.

In appearance and properties the benzene extracts of both samples resembled gutta-percha or balata, and were quite distinct from rubber. No information regarding the preparation of this material from *Gymnosporia acuminata* appears to be available, but it is recorded (*Gummi-Zeitung*, 1908, **22**, 1093) that several species of *Gymnosporia* contain a substance of this nature, the commercial possibilities of which do not appear to have been investigated.

The yield of 3·5 per cent. of a gutta-like material from the sample (No. 2) of twigs and leaves compares very favourably with that stated to be obtained in the East from the leaves of gutta-percha trees (*Palaquium* spp.), it being recorded that on the Government estates in Java a yield of 2·7 per cent. is obtained. On this basis the yield of 10 per cent. from the sample (No. 1) of bark may be regarded as very satisfactory.

At the present time there is a good demand for gutta-percha at satisfactory prices, the white Tjipitir kind, which is employed for the manufacture of golf balls, being quoted at 3*s*. 3*d*. per lb. in the United Kingdom (July 1935). It thus seems that it might be worth while to investigate the properties of this gutta-like product more fully and to

submit samples to the trade for technical trial in comparison with ordinary gutta-percha. It has, therefore, been suggested that, if feasible, a large sample of the gutta should be prepared in South Africa and forwarded to the Imperial Institute for this purpose.

ARTICLES

SCIENTIFIC ASPECTS OF CACAO FERMENTATION

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PART III

The Pulp and the Sweatings

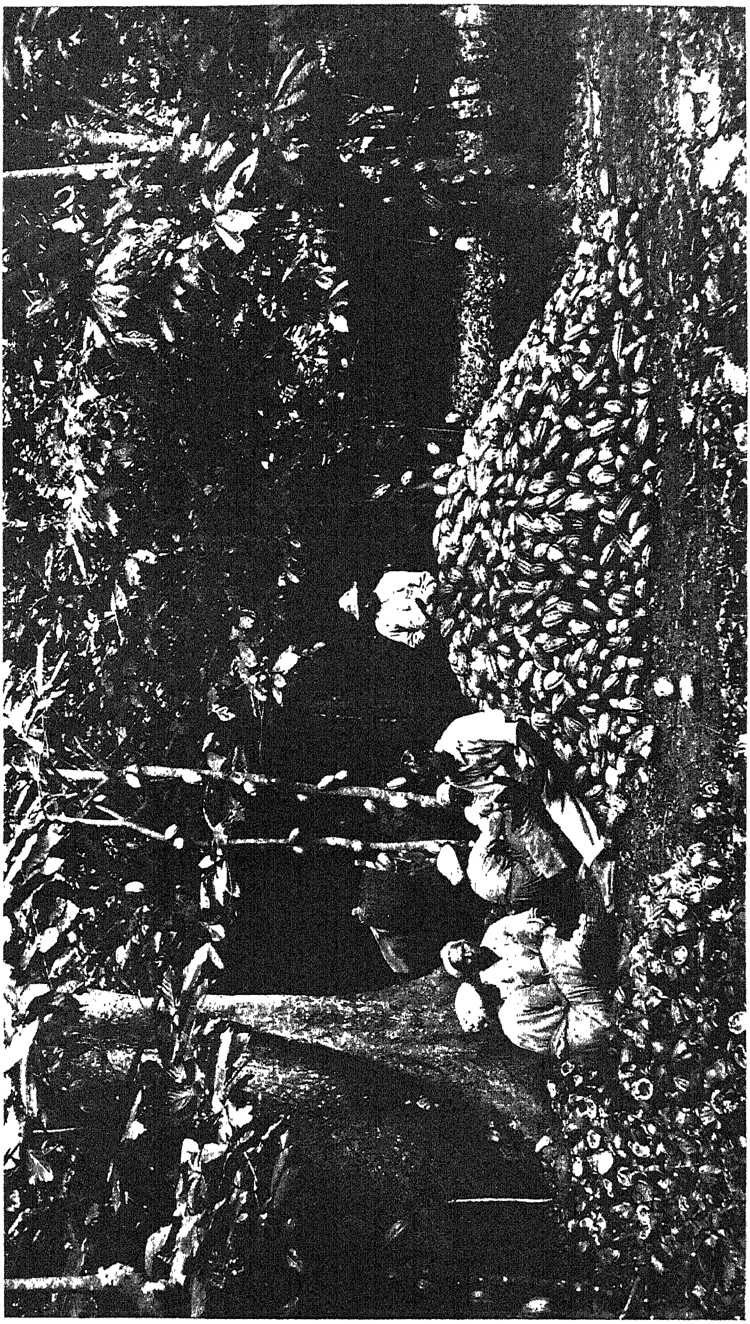
The micro-organisms have been fully discussed in previous parts of this article, but little has been said about the medium on which they grow, namely, the pulp. The pulp varies both in amount and moisture content. The following analyses were made by Nicholls [5] in St. Lucia, and illustrate the considerable variation in composition which occurs.

Percentage Composition of Fresh Pulp

	Minimum.	Maximum.	Average.
Water	79·73	88·5	80–90
Albuminoids, astringents, etc.	0·56	0·72	0·5–0·7
Glucose	8·34	13·12	8–13
Sucrose	0·40	0·95	0·4–1
Starch		Trace	
Non-volatile acids (reckoned as tartaric)	0·25	0·42	0·2–0·4
Iron oxide	0·03	0·03	0·03
Salts (potash, soda, calcium and magnesium)	0·40	0·45	0·4–0·45
Volatile acids	Nil	Nil	Nil
Alcohol	Nil	Nil	Nil

The absence of alcohol and volatile acids shows that Nicholls' samples were fresh.

Schwarz [18] found the hydrogen ion concentration of the pulp on Gold Coast beans from ripe pods was 3·8–4·0 and from unripe pods 4·0. Apparently the pulp changes little in *p*H on ripening. The author tested the pulp from a mixture of pods as gathered for fermenting on the Gold



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Opening the Pods and Extracting the Beans (Trinidad).

The pulp-covered beans are placed in small baskets.

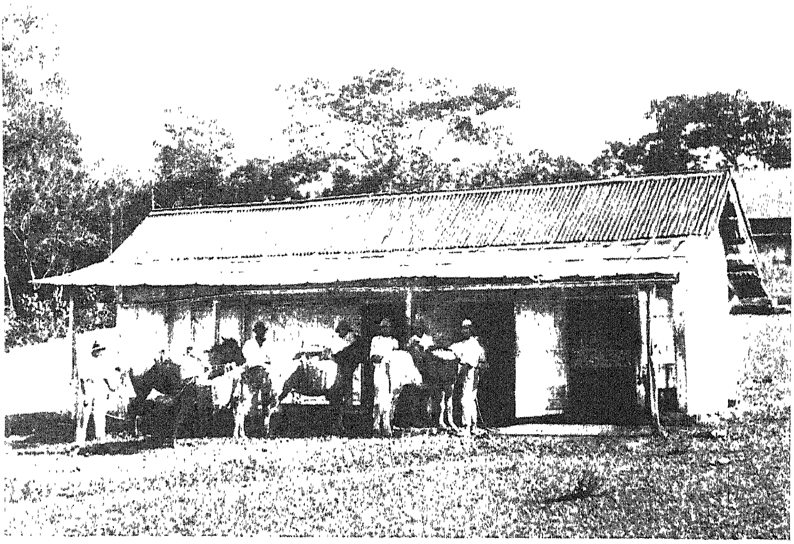

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FIG. 1.—DELIVERING THE DRIPPING PULP-COVERED BEANS TO THE SWEATING BOXES (Trinidad).

The fermentary contains six boxes in front and six at the back. The boxes are about 5 ft. by 4 ft., with movable partitions. They are raised above a concrete floor which has channels to convey the sweatings away.

FIG. 2.—A LARGE FERMENTARY (San Thomé).
Showing the beans covered with banana leaves.

Coast and obtained slightly lower pH values than these. The pulp contains a high percentage of liquid, some of which is liberated by bruising and drains away when the extracted seeds are transported before fermenting. The alcoholic fermentation breaks down the cells of the pulp, and the liquid they contain flows away. This liquid is known as "sweatings," and the greater part drains away in the first 48 hours of the fermentation. From every hundredweight of dry cacao beans $1\frac{1}{2}$–2 gallons of sweatings are produced. Sweatings, as usually seen trickling from the fermenting boxes, are slightly turbid and of a pale brownish-yellow colour. The odour is yeasty and apple-like. The fixed acid in the original pulp was considered to be tartaric by Harrison [42], Bainbridge and Davies [43] and others; Fickendey [41] stated it was chiefly malic; Hardy [9] has shown it to be entirely citric. It is a little surprising to find citric acid in a fruit totally unrelated to the citrus species. The pulp has a sweet subacid taste. The first sweatings are richest in sugars and the last in alcohol and acetic acid. The table on page 308 shows the analysis of sweatings from Forastero cacao from various countries.

All Harrison's results were originally expressed to three places of decimals. They have been reduced here to two. He gives the following percentages for the mineral constituents: iron peroxide 0·04, magnesia 0·07, lime 0·03, potash 0·35, sulphuric anhydride 0·02, phosphoric anhydride 0·04 and chlorine 0·01. It will be seen that the "sweatings" are similar in all countries and in general composition differ little from the original pulp. As the sweatings age fermentation continues with loss of sugar and production of alcohol and acetic acid. The low percentage of reducing sugars and high percentage of alcohol in the sample from Jamaica show that it had undergone fermentation before analysis.

The Total Acidity

According to Nicholls the original pulp contains a total acidity which, reckoned as citric, averages 0·28 per cent. The author found a greater percentage of acid both in the pulp and in the first drainings. As the sweatings quoted in columns 1 and 2 of the table were preserved with formalin

THE JUICE OF THE PULP (EARLY STAGES)

Place.		Ceylon.	Trinidad.		Cameroons.	British Guiana.	Jamaica.
Botanic Variety.		Forastero.	Forastero.	Forastero.	Forastero.	Forastero and Calabacillo.	Forastero.
Period of collection.		From Beans straight from pod.	0–18th hour.	4th–24th hour.	Juice of Pulp.	Sweatings.	0–15th hour.
Specific gravity		1·064	1·066	1·060	1·063	—	—
Total solids	per cent.	15·1	15·2	12·68	—	15·18	5·75
Reducing sugars	,,	—	—	10·05	10·0	11·60	3·50
Sucrose	,,	—	—	—	—	0·64	Nil.
Total acids (as acetic)	per cent.	1·4	1·4	—	—	—	0·78
Non-volatile acids (as tartaric)	,,	—	—	—	—	0·34	—
Volatile acids (as acetic)	,,	—	—	—	—	0·89	0·58
Total acidity		0·23 N.	0·23 N.	0·20 N.	0·10 N.	—	—
Volatile acidity		—	—	0·15 N.	—	—	—
*p*H of sweatings		—	—	3·9	—	—	—
*p*H of volatile acids		—	—	3·1	—	—	—
Ash	per cent.	0·68	0·60	0·78	0·64	—	0·51
Pectin and mucilage	,,	—	1·90	1·76	3·0	—	1·97
Pectin	,,	—	—	0·97	—	—	—
Theobromine	,,	nil	0·02	—	—	nil	—
Caffeine	,,	nil	nil	—	—	nil	—
Nitrogen	,,	—	—	—	—	0·05	0·05
Alcohol	,,	Trace	Trace	Trace	—	0·19	4·88
Colour		Dirty yellow, cloudy	Light buff, cloudy	Pale buff, turbid	—	—	—
Odour		Sweet, alcoholic	Sweet, alcoholic, vinegary	—	—	—	—
Reference		Knapp (1924)	Knapp (1924)	Hardy (1925)	Fickendey (1913)	Harrison (1897)	Bainbridge and Davies (1912)

and examined in England, particulars are also given of samples examined on the spot. The author put 300 lb. of Trinidad cacao straight from the pods into a clean barrel with a perforated bottom. The acidity of the pulp was equal to 0·12 N, or contained about 0·8 per cent. citric acid. In 18 hours about 7 pints of sweatings were collected. They were tested 6 hours later and the acidity was 0·15 N (or total acidity as citric acid was 0·98 per cent.). A further 5 pints were collected between the eighteenth and fortieth hour. The acidity of this was 0·13 N (or total acidity as citric acid was 0·85 per cent.). It will be noted that the acidity of the sweatings collected at the later period was not the greater, and this appeared to indicate either that little or no acetic acid had been produced up to that stage, or that the acidity was being neutralised. Steinmann's more detailed figures [24] for Java cacao (presumably forastero-criollo) also show a rise and fall in the total acidity. He took samples of the sweatings flowing away every 6 hours. Starting with an acidity on the average equal to 0·17 N, he obtained a definite increase in the twelfth-hour sample, and the acidity reached 0·24 N generally by the eighteenth hour, but after this it fell, reaching about 0·22 N by the thirtieth hour.

Hardy found that the actual citric acid in fresh pulp was 0·7 per cent., but in sweatings (fourth to twenty-fourth hour) whilst he found the total acidity equal to 0·20 N, the fixed acidity was only equal to 0·05 N or 0·33 per cent. citric acid, with the volatile acid three times this amount. Harrison's figures for sweatings support these results. Hardy's figures imply that in the first 24 hours part of the citric acid is decomposed, and a volatile acid produced (presumably acetic acid from alcohol). In the *fermented* sweatings which Bainbridge and Davies examined they found the non-volatile acid was tartaric, and they detected no succinic, citric or malic acids.

The author attempted to get some insight into the changes taking place in the pulp in the first 40 hours by noting the changes in the composition of the sweatings which ran from the pulp at different times [12]. These sweatings were preserved with formalin, and examined in England.

SWEATINGS AT DIFFERENT PERIODS (TRINIDAD)

Period.		0–18th hour.	18th–19th hour.	40th–42nd hour.
Specific gravity		1·066	1·050	1·039
Total solids . .	*per cent.*	15·2	10·9	7·9
Total acids (as acetic) .	,,	1·4	1·2	2·0
Rotation in 100 mm. tube . .		−1·0°	−0·9°	+0·1°
Ash	*per cent.*	0·60	1·36	0·83
Pectin and mucilage .	,,	1·9	2·1	1·6
Theobromine . .	,,	0·02	0·03	0·03
Caffeine	,,	nil	0·005	0·005

These samples illustrate well the decrease of gravity and sugar percentage with time. The appearance of minute amounts of theobromine and caffeine is worth noting. There is a slight fall in acidity for the eighteenth to nineteenth-hour sample and an increase in the fortieth to forty-second-hour sample. Unfortunately, the nature of the acidity was not determined.

Staner [49] on the Belgian Congo has shown the change in total acidity of the pulp in the later stages of fermentation. The method he used was to determine the total acidity of a fixed number of beans. He started his tests as soon as he noted acetic fermentation, that is on the fourth day. As the amount of pulp only diminishes slowly after this, his figures give a good indication of the variation in the total acidity of the pulp. His figures for the ccs. N/10 NaOH to neutralise the pulp on four beans are, on the fourth day, 2·5; fifth, 3·7; sixth, 4·5; seventh, 5·5; eighth, 2·5; ninth, 2·0; tenth, 1·5. The acidity more than doubles between the fourth and seventh day, and then sharply falls. Obviously this fermentation was carried too far; the exact point at which it is advisable to stop will be considered later when the effects of acetic acid on the interior are discussed.

In relation to acid production, Eckmann [25] states that the action of cacao wine yeasts (*S. ellipsoideus*) is reduced by an acetic concentration of 0·5 per cent., and that at 1·2 per cent. the yeast is killed.

There is always the possibility of the development of other acids than acetic in the pulp, but the author is not aware of any detailed analyses showing these. As succinic acid is a normal metabolic product of yeast it must be present, although probably only in small quantities. Other bacteria than acetic bacteria may attack the alcohol

and convert it into organic acids, e.g. lactic acid. Henneberg found only round forms (cocci and streptococci) of lactic acid bacteria and came to the conclusion that they are not particularly suited or important to cacao fermentation. Butyric acid, fortunately, is rarely produced. Busse [46] says, "To the fungus pests of the fermentation belong also the mycoderma (a group of mould ferments) which Koeppen always found in the fermenting cacao in the Cameroons and San Thomé. They attack the sugar, destroy the alcohol and various organic acids, but they can form at the same time volatile acids, amongst which butyric acid is the most dangerous for the cocoa. They have a long life and much capacity of resistance against higher temperatures."

A *p*H of 4 is accepted as the average acid limit for bacterial growth. Hardy's figure for the *p*H of the sweatings is 3·9. They are thus less strongly acid than such fruit juices as apple, lemon, orange, plum and gooseberry, but they are acid enough to retard the growth of bacteria. The *p*H of the pulp rises and exceeds 4 as fermentation proceeds, so that the conditions for bacterial growth improve.

Whymper [44] found that the *p*H in the pulp plus skin changed during fermentation as follows: originally 3·6, it became 3·8, 4·2, 4·8, 5·7, 6·4, 6·5 on six successive days—thus the effective strength declined as the amount of acetic acid increased, presumably because of the presence of buffers, such as citrates or acetates. Fermentation increases [42] the percentage of magnesia in the skins by 0·4, potash by 0·6, phosphate (as phosphoric anhydride) by 0·2 and the combined fixed organic acid (as tartaric) by 1·5.

There is present 0·19 per cent. of boron expressed as boric acid in the dried pulp [45]. It is not known in what form it exists, but it apparently has no appreciable retarding effect on the bacteria or moulds during fermentation and drying. The author considers that A. S. Dodd's discovery of boron (about 0·05 per cent. expressed as boric acid) in all the Forastero and Criollo cacao beans examined may be of importance in relation to the agriculture of cacao, as the depletion or deficiency of boron in a soil may render it unsuitable for cacao cultivation.

Visible Changes in Pulp and Skin

The pulp gradually loses its glutinous nature and finally becomes a thin coating of paste on the bean, so that if it is washed the pulp comes away as particles and not as slimy threads. It also changes colour. The first day it is white or tinged with pink ; second day, pale pinkish-brown ; third day, pinkish-brown ; fourth day, light brown ; fifth day, brown. On the fifth day the author, in examining the pulp under the microscope, noted that it contained a considerable number of brownish-yellow spherical bodies which he could not identify. In size they resembled cacao starch.

The brown colour of the pulp is due to the oxidation of a tannin in the presence of an oxidase, and is the planter's main guide in determining the correct end-point of the fermentation. Whymper [44] has shown that a water extract of the original skin and pulp gives no colour with ferric chloride and, therefore, is free from tannins. By the third day the water extract of the skins gives a coloration showing that they have acquired tannins from the cotyledons inside. This explains the observed fact that the clean shells of unfermented beans are bright reddish and that the shells obtained are darker and browner the longer the fermentation and the longer the exposure to air and sunlight during drying. An illustration of this occurs with Guayaquil cacao, which often has a percentage of beans with light shells. The opinion of the *Gordian* in 1925 was that these were washed. The author investigated this and found they were not washed [47]. The beans were light or dark skinned according to their position in the heap during the casual fermentation they undergo and the light ones were those which had been less exposed to oxidation. Regular mixing would give an even and more desirable product.

The purple, purple-brown or brown patches which appear during fermentation in the pulp and on the skin of the bean are due to exudations of the juice in the cotyledons through a break in the skin. The juice is brown in Criollo and purple-brown in Forastero beans. It may exude through a cut in the bean (one bean out of the forty in the pod is often cut by the cutlass used for opening),

but more generally these patches are noticed in the later stages of fermentation, frequently at the shoulder of the broad end of the bean (probably at the place where the placental attachment occurs). They generally appear on beans in a warm place near the surface of the mass, and their appearance is regarded by planters as a warning that fermentation has been carried far enough.

Under some circumstances, if the fermentation is carried too far and the pulp dries up, the fermenting mass, instead of giving off a sweet acid odour, develops an ammoniacal smell and a suggestion of putrefaction. Whymper states that if carried still further acetamide is formed. The colour of the skins becomes black, a development which occurs earlier with Criollo than with Forastero cacao. The blackening is accelerated by high temperatures and is due to the action of the tannin in the presence of ammonia. In the early stages the skin only is affected, and planters are aware that the colour of the skins can be brought back by the addition of an acid (e.g. diluted lime juice). Blackening should always be avoided, as there is a serious risk of spoiling the cacao. The blackening of the skin mentioned here should not be confused with the black cacao which is obtained from pods which have been attacked by a certain parasitic fungus (*Phytophthora Faberi*), and is usually separated from the healthy cacao before fermentation.

The beans when put into the sweat box have a delicate melon-like odour. After three days this changes to a heavy, sharp, fragrant odour, such as might be given by a mixture of ethyl and amyl esters with a little acetic acid. Later, the odour suggests sour barm. Bainbridge and Davies found various esters, including amyl propionate, amyl acetate and amyl butyrate in the distillate from cacao nibs. Some writers (e.g. Busse) consider that just as in wine the bouquet is produced by esters, so in the case of cacao, esters produced in the fermentation of the pulp permeate the bean and give it the characteristic odour. Any odour due to these esters is present in the raw cacao. The most notable characteristic of the odour of raw cacao is the sharp pungency of vinegar. Behind that is often a very faint pleasant odour, wine-like or reminiscent of sweet

heavy smells like geranium. On roasting, a much stronger and quite different aroma is developed which is characteristic of chocolate. The esters produced in the pulp add a faint fragrance to the raw cacao, but roasting drives some of them off, and it appears unlikely that they are an important part of the characteristic aroma of the roasted bean.

The Central Stalk or Placenta

When the beans are removed from the pod, according to its degree of ripeness, they are more or less held together by the central stringy stalk, placenta or core. If the beans are left in a mass like this they do not ferment so readily, and if after turning they remain in twos or threes stuck together, they are very liable to mould during drying. The beans should always be removed from the placenta and separated from each other. The question arises as to whether the free placentæ should be put to ferment with the beans. There is no disadvantage in their inclusion and there is a definite advantage when the pulp is scanty. The composition of the placenta is not the same as that of the pulp, for example, it is only very faintly acid, the pH being about 5. When the placentæ are separated from the beans they are thrown away. The author had some dried, in which condition they weighed ten to the ounce and kept perfectly. They contain pectin, and when extracted with dilute acids yielded a jelly with a honey-like aroma.

The Use of Sweatings

When cacao is fermented in a heap on the ground, the sweatings sink into the earth, and as a new position for the heap is chosen each time a fresh one is made, one is not conscious of the sweatings. Where boxes are used, the sweatings are often carefully drained away and sometimes collected. They are very unstable and continue to ferment. One would like to see this by-product, which is often a nuisance to the planter, made use of. The author has heard of sweatings being used in a way that cannot be recommended, that is to pour over unfermented beans, prior to drying, to give them the acid tang that is associated with fermented cacao. The author has suggested [12] that

planters might with advantage use the first day's sweatings from one box to pour over the fresh cacao just put in the box, particularly when the pulp on the bean is small. This would give a flying start to the fermentation. Briton-Jones has pointed out that this method has certain risks, and if used by uneducated farmers would not be likely to give consistent results.

It is evident from its character and composition that sweatings could be used to produce a drink resembling cider, which would contain besides alcohol minute quantities of the stimulants caffeine and theobromine. There is present also a small percentage of pectin and mucilage (the addition of alkali causes the sweatings to gelatinise), and cacao-jelly is said to be occasionally prepared from it. Sweatings also contain citric acid, but the amount is so small that, if recovered from the sweatings, it would cost more than when prepared either from lemon juice which contains ten times as much, or by the recently introduced fermentation process. Samples of fresh sweatings sent from Trinidad in bottles to England were found by the author to contain from 6 to 9 per cent. of absolute alcohol by volume. In Grenada in 1924 a satisfactory yield of industrial alcohol was obtained from sweatings, but there stood in the way of commercial success the difficulty and expense of obtaining a sufficient quantity from so many scattered cacao estates.

Hudson [5] has shown that sweatings will yield a mellow but strong rose-coloured vinegar, the average percentage composition of which is: acetic acid 6·2, extract 1·7 and ash 0·25. The only way to exploit these possibilities on a commercial scale would be to deal with very large quantities of cacao at one fermentary and have the sweatings treated under scientific control. With the growth of central fermentaries, such as exist in Nigeria and Tobago, this may become possible.

Fermentation for Short Periods

(*a*) *Criollo*

We have seen that with Forastero cacao, fermentation for a period of about six days gives good results. The Criollo variety is always given a shorter period, generally

from one to three days. This is partly because it has a thinner and more permeable skin, often covered with only a little pulp, and partly because it has originally less astringency and loses what it has more readily. It also becomes plump and develops a brown colour in a shorter time. The cotyledons are only partly brown after these brief periods of fermentation, but they become completely brown on drying. The Criollo bean is sweeter than the Forastero, and this is connected with its lower content of theobromine [37] which has a bitter taste. It is generally agreed that the Criollo bean is less astringent, although Adam [38] finds that the tannin content of commercial Criollo and Forastero beans appears to differ very slightly.

All that is considered necessary in the case of Criollo cacao is to ferment sufficiently long to loosen the pulp, after which in some countries it is washed off and in others the beans are coated with earth. In Venezuela, Criollo is generally in the sweat box one day only, but the period in which desirable changes take place is lengthened by spreading on floors in the sun or heaping and covering the warm cacao. Before drying it is rubbed with red earth. With certain types good results are obtained by fermenting for 36 hours, then transferring to the drying platform for sunning, and then putting back into the sweat box for a further 36 hours. In Ceylon the method for Criollo is to ferment for 24 hours, then wash, and then repeat the fermentation and washing. In Samoa [7] and Java [24, 48] high temperatures are rapidly obtained :

TEMPERATURES OBTAINED DURING FERMENTATION

Country. Observer.	Samoa. Demandt.	Java. De Lange (1908).	Java. Steinmann (1928).
After 24 hours . . .	45° C.	35–40° C.	29–35° C.
,, 48 ,, . . .	48° C.	45–50° C.	41–45° C.
,, 60 ,, . . .	49° C.	46–47° C.	48–50° C.

These temperatures show a more rapid rise than those recorded for Forastero cacao fermented in boxes, but resemble those obtained with heaps on the Gold Coast. They are in direct contrast to those recorded for Criollo in Ceylon [39]. It is doubtful whether in Ceylon 40° C. is ever exceeded. The seeds (both germ and cotyledons), however, are killed. Further, the pulp is partly removed with little production of acidity.

It is to be regretted that no full study has been published which enables us to explain why the desired changes occur so much more readily in Criollo cacao than in Forastero. It is not due to the composition of the pulp, as this is similar to that on Forastero beans [40]. It may be due to the cotyledons containing none (or very little) of the purple substance (found in Forastero beans) which is more stable than the colourless catechin which both contain. What is more important is that the oxidation of the tannins can occur over a wider range of temperature, as is evident from the following considerations. There is little doubt that the Criollo bean is killed at a lower temperature than the Forastero, and according to Fickendey [40] the oxidase in Criollo beans is more stable to heat, a temperature 5–10° C. higher being required to destroy its activity.

(*b*) *Forastero*

These short-period methods are also used in some countries for Forastero cacao. The results are unsatisfactory. For example, in Ceylon the method described above for Criollo has also been used for Forastero cacao. By this method a bean with a beautiful clean red-brown shell is obtained, but on cutting the bean in two the interior has all the characteristics of unfermented cacao. The planter has merely succeeded in getting rid of the pulp and retaining the fine colour of the shell without improving the part of the bean used by cocoa and chocolate manufacturers. This appears to be a new practice: Dr. Alex Preyer in 1901 wrote of Ceylon that "no European out there sends unfermented cacao to market."

It is generally recognised that the cacao from Ecuador possesses a characteristic flavour and aroma. The beans are taken from the pod and simply spread out on the drying platforms. The heat of the sun is sufficient to destroy the ability to germinate of those beans which are on the top layer, so that some of the changes associated with fermentation occur locally. The beans are heaped up during the night, when yeasts develop and an irregular partial fermentation takes place. No attempt is made to carry the fermentation to completion. The method has the advantage that little or no acidity is developed—it has

the disadvantage that only 60–80 per cent. of the beans undergo any fermentation whatever, the interior of the remainder showing them to be completely unfermented. (It has been suggested that the characteristic fine aroma of the cacao from Ecuador is due to some peculiar organism of fermentation. The fermentation is so irregular and incomplete that this is an improbable explanation. The aroma may be due, as is sometimes stated, to the nature of the soil or the climate, but more probably it is due to the cacao being a characteristic form of Forastero peculiar to Ecuador. Certain it is that in spite of its inferior preparation for the market, this cacao is highly prized. It would be improved by a carefully controlled and uniform fermentation.)

In some producing areas, either through ignorance or carelessness, Forastero cacao is only fermented for one or two days. The results are deplorable. Thus in Fernando Po [18] the entire fermenting period is about 36–48 hours, and the product is definitely under-fermented and inferior.

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THE ECONOMIC RESOURCES OF CYPRUS

In March 1934, the Secretary of State for the Colonies appointed Sir Ralph Oakden, C.S.I., O.B.E., as Financial Commissioner for Cyprus "to examine and report on the financial position and policy of the Government of Cyprus in relation to the economic resources and prospects of the Colony, and in particular to advise as to the development of those resources and as to any change which may be necessary or desirable in the existing basis of revenue and in expenditure on services." Sir Ralph Oakden spent about four months in the island, from the middle of April to August 1934, and was accompanied by Mr. F. G. Lee as Secretary. The comprehensive Report he submitted to the Secretary of State, occupying 178 foolscap pages, was published on behalf of the Government of Cyprus by the Crown Agents for the Colonies early this year (price 6*s*.).

After an introductory sketch of the island, the report gives a brief review of the economic production of Cyprus, especially of the agricultural position and its possible future developments. The present general financial position of the Colony is reviewed, and certain principles regarding financial questions are put forward, which, in Sir Ralph Oakden's opinion, should control and determine the future policy of Government. Revenue is then considered and the work and organisation of the principal Government Departments are submitted to critical examination. Then follow three chapters relating to rural indebtedness, the position of the Agricultural Bank and Co-operative Credit Societies. Finally, there are chapters

on what is regarded as the most urgent necessity in Cyprus, viz. the provision of further water supplies, especially for irrigation, and on certain miscellaneous subjects.

The main recommendations relating to economic production and resources, water supplies and the Agricultural and Forest Departments may be summarised as follows:

Economic Production and Resources.—The system of controlling wine exports to the United Kingdom by licence should be maintained, subject to a minor modification.

The present action to improve cotton should be encouraged.

There should be no further expenditure on the encouragement of flax production for export.

Local consumption of Cyprus tobacco should be encouraged.

The price charged for wild olive trees might be further reduced.

A financial subsidy for the silk filature at Paphos would not be justified.

The livestock industry and the growth of fodder crops should be stimulated.

The reduction of the royalty rate on asbestos should be maintained, if necessary, during 1935. Similarly the waiving of the duty on gypsum should be continued for the present.

Water Supplies.—The maintenance of a permanent and adequate forest cover on the hills is the basis of all policy in the matter of water conservation.

Government should apply for a loan of £5,000 a year for five years from the Colonial Development Fund to be available for re-lending to individuals and co-operative societies to finance irrigation works.

The risk of expenditure on deep boring would not be justified, but the question might be further explored by a geologist, who could visit Cyprus for a short time.

In view of the paramount importance of water supplies Government should place their development in the foreground of its administrative and agricultural policy.

Agricultural Department.—The proposed reorganisation of the Department, involving the creation of a number of agricultural divisions under separate officers and the

absorption of some of the specialist officers into the general field staff, is considered to be on sound lines and should be carried out as soon as possible.

It is recommended that the Governor should apply to the Colonial Development Fund for assistance towards capital expenditure required at the experimental stations at Saitta, Trikoukkia and Morphou.

The establishment of a Produce Inspection Service is recommended.

Further expenditure on the purchase of stock animals is desirable.

The amount allocated for expenditure on agriculture should not in normal circumstances be allowed to fall below the present provision.

Forest Department.—The proposed curtailment of the commercial activities of the Department is supported.

The efforts of the Department should be concentrated on the main forests.

Control over " scrub areas " should be relinquished forthwith and transferred to Commissioners.

Generally, a more liberal administration as regards forest offences is desirable.

The number of forest divisions can be reduced, two posts of Assistant Conservator abolished, and a saving of £1,000 made in 1935, in addition to the saving brought about by the curtailment of the Department's commercial activities.

The introductory chapter of the Report and that dealing with economic production and resources form an excellent survey of the Colony, and in view of their general interest, are reprinted, largely *in extenso*, in the following pages.

Description of the Island

Cyprus is an island in the eastern Mediterranean, lying between 34° 33′ and 35° 41′ N. latitude and between 32° 30′ and 34° 35′ longitude. It is separated from the southern shores of Asia Minor by a strait about 45 miles wide. It is 240 miles distant at the nearest point from Port Said and some 60 miles from Syria.

Its area is 2,293,760 acres (3,584 square miles), or a little larger than Norfolk and Suffolk combined. It is the third largest island in the Mediterranean, being exceeded

in area by Sardinia and Sicily only. The greatest length of the island (from west-south-west to east-north-east) is 140 miles: the greatest breadth (from north to south) 60 miles. The figure for the greatest length is increased by the fact that a narrow tongue of land (10 miles wide), known as the Karpass, juts out from the main part of the island to the east-north-east for a distance of 45 miles.

There are two separate groups of mountains with a wide plain between. The limestone range known as the Kyrenia Mountains extends in a superb and unbroken chain for a distance of nearly 100 miles along the north coast, at an average height of 2,000 ft. There is a narrow but well-watered and fertile coast plain between the range and the sea. Most of the south-west of the island is filled by an extensive group of mountains and hills, culminating in Mount Troodos, 6,400 ft. above sea-level. There are several other peaks of over 4,000 ft. in this area. Between the Kyrenia range and the Troodos mountain system lies a broad tract of almost treeless plain, known as the Messaoria, some 60 miles long (i.e. from east to west) and 20 miles broad. The Kyrenia mountain range, the mountain and hill area in the south-west and the Messaoria plain constitute the three main natural features of the island. The rivers are little more than mountain torrents which bring down flood water after the winter rains. There is no permanent stream of any volume. The two largest rivers are the Pedias and the Ialias, which traverse the Messaoria from west to east. Neither is permanent.

Of the total area of 2,293,760 acres, 1,600,805 acres are alienated. Of this latter area it is estimated that 494,736 acres were cultivated in 1933. Of the cultivated land, wheat, barley and vines account for the largest acreages, with estimated areas of 177,305, 106,286 and 119,277 acres respectively in 1933. Only to one other crop is an area of over 6,000 acres devoted—vetches, with an estimated area in 1933 of 50,574 acres. The above statement of the position would, however, be misleading if it were not mentioned that there are large and undefined areas, chiefly in the low hill country, devoted to the production of carobs and olives. In many cases cereal crops are grown in the groves between the carob and olive trees. The great bulk

of the cereal production takes place in the Messaoria plain: vines are confined chiefly to the hill country of the south-west. The area of delimitated forests is 405,088 acres, or nearly 18 per cent. of the island. This area includes, however, many isolated patches of "scrub" forest of little value, as well as isolated plantations of trees: the true forest areas are confined to the mountain ranges in the north and south-west, where the main trees found are the pine, the oak and the cypress.

The climate of the island is, generally speaking, temperate and healthy. The mean temperature at Nicosia (in the Messaoria plain) over a period of ten years was 66·1° F., but there is a very considerable range between a cold and invigorating winter and a torrid summer. Thus at Nicosia, over a 15-year period, the average absolute maximum temperature was 105° F. and the average absolute minimum 32°—a range of 73°. Naturally in the hill country the summer heat is less severe, and, in consequence, a number of hill resorts have come into existence at varying altitudes where the summer can be spent without discomfort. Even in the plains the heat, though trying, is, except near the sea, generally dry; and (at Nicosia in particular) the temperature drops at night.

Most of the rain falls in the winter months; in summer, after June, the plains become parched and desolate, and practically all vegetation disappears from them. Unhappily the rainfall, rarely abundant, varies considerably from year to year; and there are periodic years of deficiency, when a shortage of rain may cause considerable loss and suffering owing to the consequent decrease in crop production and the curtailment of supplies for drinking. Returns of rainfall over a period of years are given in the table below.

RAINFALL RETURNS, 1924 TO 1933 (IN INCHES)

	Average over 10 years.	Highest.	Lowest.
Famagusta	16·08	25·17 (1926)	7·46 (1933)
Nicosia	13·21	19·44 (1924)	6·82 (1932)
Morphou	11·01	16·62 (1926)	6·61 (1932)
Stavros[1]	35·74	49·27 (1928)	21·60 (1933)
Larnaca	19·07	30·98 (1926)	7·87 (1933)
Limassol	17·42	28·45 (1926)	7·69 (1933)
Paphos	18·45	28·37 (1929)	10·22 (1933)

[1] *A forest station in the Troodos mountains.*

Rainfall fell considerably below the average in the years 1931–33—these unhappy years formed the driest consecutive 3-year period since accurate returns were first kept, that is since the British occupation in 1878. It is the recurrence of such periods of drought or semi-drought that constitutes the chief (indeed the only) natural ill from which the island is liable to suffer; there are no cyclones, and earthquake shocks, though felt nearly every year, are rarely serious.

Population

The population of the island, as shown in the census for 1931, was 347,959, an average of 97 persons to the square mile; it was estimated to be 357,934 at the end of 1933—177,576 males and 180,353 females. The above totals compare with returns of 186,173 in 1881, 274,108 in 1911 and 310,715 in 1921. The birth rate is estimated to be 27·4 per 1,000 and the death rate 13·8. Infantile mortality is, unhappily, high.

The inhabitants fall into two principal divisions—Orthodox Greek Christians (belonging to the Autocephalous Church of Cyprus) and Moslems. Their proportions are roughly 4 to 1. There is a small but steadily increasing Armenian community; and a feature of the last four years has been the settlement, chiefly near Kyrenia, of a number of English families, mainly pensioners from the army or the overseas services.

The language spoken by the Greek-Christian population is modern colloquial Greek; that by the Moslems Osmanli-Turkish. Most of the Moslems can understand and speak Greek; the converse rarely holds. The presence in the island of two separate communities each determined to remain separate and each with its own language, adds very considerably to the complexity and cost of administration. English, which is the official language, has hitherto been little spoken; but its use is increasing and may be expected to do so much more rapidly now that an adequate knowledge of English has been made compulsory for all entrants to the Government service (including the police). English is also the only language medium recognised for

the Executive Council and the recently established Advisory Council.

As befits members of an agricultural community, the majority of the inhabitants of Cyprus live in villages. There are 642 villages in the island with populations varying from 20 to 3,000 persons. The towns are normally small.

The capital and seat of Government is Nicosia, with a population of 23,507 inhabitants in 1931. (In July of each year the Governor, the Secretariat and certain Heads of Departments move to the hill station, Troodos, where they stay until the following October.) Nicosia is the headquarters of Nicosia district, the largest in the island. Five other towns form the headquarters of administrative districts—Limassol, Larnaca, Famagusta, Kyrenia and Paphos—the last two of minor importance. The following is the population of these towns as recorded at the census of 1931 : Limassol, 15,066 ; Larnaca, 11,725 ; Famagusta, 8,771 ; Kyrenia, 2,049 ; Paphos, 4,467.

In the census of 1931 it was found that of 134,279 persons (of both sexes) returned as practising occupations, 34,546 were farmers and cultivators, 22,654 were described as agricultural labourers (though it is possible that most of these own land and go out to work for part of the year), 8,861 were shepherds, 23,064 were engaged in various trades (shoe-making, weaving, etc.) and 3,197 were engaged in mines and quarries. Although the actual percentage of emigrants to the total population over a period of years is small (just over 1 per cent.), emigration is of importance since remittances to the island from Cypriots abroad (who are usually persons of enterprise forming important communities in certain centres like Alexandria) constitute an important item of invisible exports, estimated at a conservative figure of £40,000 in 1933.

Government

Cyprus has known many forms of government, and almost invariably government by some non-Cypriot power. The island passed under the administration of Great Britain in 1878, and was formally annexed to the Crown in November 1914, following the outbreak of war

with Turkey. Letters Patent were issued in March 1925, under which the island was given the status of a colony, and administration vested in a Governor aided by an Executive and a Legislative Council. The latter was abolished following the disturbances in 1931. The Executive Council consists of four official and three unofficial members, though at the time the report was written there were only two unofficial members. There has recently been established an Advisory Council consisting of the Executive Council and five unofficials, which meets as and when the Governor determines. A Central Administrative Council consisting of a number of *ex officio* members and others elected from district councils, known as the Central Mejlis Idaré, has lingered on from Turkish times ; but it has practically no functions at all and counts for nothing.

As already mentioned, for administrative purposes the Colony is divided into six districts, each under a Commissioner. In the six towns and nine of the larger villages there are municipal corporations established under the provisions of the Municipal Corporations Law, 1882. The Councils (election to which has at present been suspended) have general control, except for police supervision, of the town or village: their powers and duties include the construction and maintenance of streets, drains, lighting, water-supplies, markets, petroleum stores, slaughter-houses and the like. Their revenues are obtained chiefly from various fees and rents on municipal property and, in addition, since January 1933, the Customs Department has collected a toll on certain imports, the proceeds of which (less 7½ per cent. for collection) are divided among municipalities. There is no system of direct rating of property.

Each village, or quarter of a town, has a village authority, composed of a Mukhtar with four Azas, or village elders, to assist him. Both Mukhtars and Azas are appointed by the Governor. If there are a Greek-Christian and a Moslem community living in the same village, each community has its own Mukhtar and Azas. The Mukhtar is, in effect, the village headman and the representative of Government in the village. He has a general duty of keeping the peace within the village and of assisting

Government officers in every way possible. He is also charged with certain specific duties, such as the registration of births and deaths, the execution of writs of execution delivered to him by the sheriff, and the like. If a village so desires it may be entrusted with certain duties (e.g. the execution of any sanitary measures for the protection of public health) under the Public Health (Villages) Law of 1892. To provide the necessary funds for such measures, rates may be levied subject to the sanction of the Commissioner of the District. There are special Public Health Boards set up in three hill villages, Troodos, Platres and Pedhoulas, to control public health measures in these summer resorts.

Apart from the District Administration the departments of Government consist of the Secretariat, the Treasury, the Audit Department, the Agricultural and Irrigation Department, the Land Registration and Survey Department, the Customs and Inland Revenue Department, the Judicial Department, the Legal Department, Police and Prisons, Education, Health, the Post Office, the Forestry Department, the Railway and the Public Works Department. The headquarters of the Customs and Inland Revenue Department and of the Railway are at Famagusta ; all other Departments are centred in Nicosia.

Agriculture

In one respect Cyprus is singularly fortunate. Its economic prosperity is not dependent on one crop or one industry. The fact that the island has a large variety of exports has stood it in particularly good stead (if it is viewed as an economic unit) during the difficulties which have been experienced over the past four years. Such a "spread" of economic interests may preclude abnormal periods of prosperity (except during a very exceptional time like the war), but its value is seen as soon as prices fall and sales diminish.

Cyprus is fundamentally an agricultural country, and agriculture is the main occupation of its inhabitants. It is not wholly self-supporting in essential foodstuffs. There are considerable imports of "luxuries" like sugar, and also of flour and edible oils, but apart from these

commodities the island maintains itself, and its exports chiefly consist of a variety of agricultural products. Thus of a total export trade in 1933 valued at £810,976, £528,433 may be taken as the value of agricultural exports (including stock). (Of the balance of £282,543, two commodities, pyrites and asbestos, account for £239,867.)

Cyprus is mainly a country of small landed proprietors. Lands belonging to the Church, the monasteries and Evcaf (the Moslem religious foundation) amount to 5 per cent. of the cultivable area. Much of this is leased to tenants, though often on unsatisfactory terms ; in many cases only a yearly tenancy is put up to auction, a system which normally reduces development to a minimum. There are a number of chiftliks or large farms : in Paphos district, where the land is usually poor, there is a widespread demand that certain chiftliks, especially those belonging to absentee landlords, should be expropriated and distributed to small-holders. The further grievance is felt that in some cases a chiftlik owner, by immemorial right, owns the water of the river running through his property, not only while it is running through but after it has passed by, so that agriculturists living lower down the river have to pay heavy rates for the use of such water.

The average agricultural holding in the island is 22½ acres in extent. This does not, however, mean that the whole 22½ acres is cultivable. Mr. Surridge (*A Survey of Rural Life in Cyprus*, p. 58) has estimated that of an average (unirrigated) holding 15–20 per cent. is almost uncultivable ; a further 20 per cent. barely repays the expenses of cultivation ; 30 per cent. is moderate only, and the remainder (30 per cent.) may be described as reasonably productive arable land. Allowances must also be made for land which is allowed to lie fallow—often one-half of the cultivable area. Land tenancy, which is governed by the former Turkish law, takes a variety of somewhat complicated forms, but draft land legislation is being prepared to replace and simplify the existing law. Holdings in vine-growing districts are usually smaller than elsewhere. Waste land is used for the grazing of animals, and a total of about 215,000 acres is available for this purpose.

The total value of agricultural production (i.e. including

the value of livestock exported and the estimated value of crops not exported) is estimated as averaging £1,400,000 a year over the 5-year period 1929–1933 (exported £535,400, non-exported £873,600), with a decline to £1,000,000 in 1933. The returns which form the basis of this estimate were, however, in respect of main crops only: if the value of certain minor crops and products (e.g. almonds, onions, cumin seed, hides and skins) is taken into account the total would be increased by perhaps £30,000.

Cereals.—The cultivation of cereals is the main activity of the farming community, and fully three-quarters of the cultivated land is occupied with winter crops of wheat, barley and oats, interspersed with areas of rotational leguminous crops. Cereal cultivation predominates in the central plain and the lowlands. The lands devoted to cereal growing are either dry-fallowed during the summer or, when irrigation is possible, are sown with summer crops.

There has been some reduction in recent years in the area under cereals, especially in that under barley, which was approximately 18 per cent. less in 1933 than in 1929, while wheat acreage showed a reduction of 8 per cent. over the same period. This reduction was, however, partly due to the three years of serious drought through which the Colony has passed, which has also been responsible for very considerable falls in yields. Thus the total production of barley fell by nearly 50 per cent. in 1933 as compared with 1929; wheat production showed a decline of about 30 per cent. It is difficult to obtain any reliable figures for average yields for a given area, since the average is reduced owing to the fact that a good deal of cereal cultivation takes place on marginal land not really suitable for such cultivation. Thus during 1933 the average yield of wheat over the whole country was only about 9 bushels per acre, of which the cultivator would normally be obliged to retain one bushel for seed. On much of the land the yield is very considerably higher, especially if it is possible to arrange for irrigation—but, taken as a whole, it is true to say that yields are disappointingly low. The difficulties caused to cereal growers by reason of low yields have, of course, been much accentuated during recent years by a serious fall in prices, especially in wheat prices, which

began in 1928. This fall is largely due to the increased import of cheap flour, rendered possible by the low world price for wheat. The table below gives the areas under wheat, barley and oats during the last five years, and the estimated production during these years. It should be mentioned, however, that the figures are approximate only and must be accepted with some reserve (there is no system of " crop records " as in India).

CEREAL PRODUCTION, 1929–33

	Wheat.		Barley.		Oats.	
	Area.	Yield.	Area.	Yield.	Area.	Yield.
	Donums.	*Bushs.*	*Donums.*	*Bushs.*	*Donums.*	*Bushs.*
1929 .	588,262	2,195,173	379,549	2,820,763	37,509	241,229
1930 .	556,935	1,873,259	370,892	2,378,359	34,701	201,013
1931 .	554,369	1,623,122	280,547	1,331,424	39,374	214,879
1932 .	514,813	1,144,243	283,394	1,041,556	34,443	122,224
1933 .	531,916	1,585,385	318,860	1,583,621	32,154	168,867

1 *donum* = 14,400 *sq. ft. or just under* ⅓ *acre.*

The very serious decline in returns from cereal growing has given rise to natural and widespread anxiety, and many suggestions have been put forward with the object of raising the price to the local grower by the curtailment or prohibition of imports of flour. This is a question of considerable importance, and, as such, it is examined separately in the body of the Report. Sir Ralph Oakden recommends that the Government should consider the possibility of introducing, in co-operation with the municipalities, a scheme providing for the compulsory use of a percentage of Cyprus flour by bakers, or alternatively that they should examine the possibility of re-introducing a system of sliding-scale duties as in Palestine. He points out, however, that, until there is a general improvement in the world wheat market, no very marked improvement can be hoped for—whatever action may be taken by Government—in the present position of cereal growing in Cyprus. It will remain a " depressed industry." No easy or rapid amelioration can be hoped for, but cereal growers should be encouraged to look for an improvement in their economic position by a greater attention to increased acreage yields, to the development of animal husbandry and to the further diversification of crops under irrigation.

Carobs.—These form by far the most important export crop. Out of a total export value for agricultural products of £528,433 in 1933, carobs (including ground carobs and seed) accounted for over £122,000. They constitute the chief money crop of the low hill country. Trees are found either in properly constituted groves of grafted plants or (more usually) scattered throughout the small-holdings, where the cultivation of cereals and sometimes of other crops is carried on between the crops. The carob producer is usually a small man, owning a few trees, or even shares in a single tree. It is reported that the cultivation of carobs has been considerably neglected during the last few years. The following table shows the estimated production and export during the last five years; it may be noted that normally considerable stocks are held in the island by exporters (usually merchant money-lenders) awaiting disposal:

Year.	Production.	Price to producer per kantar.[1]	Exports (whole and ground carobs).	
	Tons.		*Tons.*	£
1929	58,422	29*s.*	28,779	171,264
1930	110,437	14*s.*	41,465	116,920
1931	69,985	10*s.*	70,037	141,889
1932	38,555	14*s.*	62,268	181,811
1933	22,834	17*s.*	33,228	179,929

[1] 1 *kantar* = 0·225 *ton.*

Production during 1933 was the smallest recorded during a decade owing to the cumulative effect of years of drought. A better crop was expected in 1934. Two companies kibble the beans locally for the extraction of the seed, but one of these did not operate in 1933.

The chief market for carobs has hitherto been the United Kingdom. Owing to a falling-off in the demand from that country in 1933, small new markets were found on the Continent, especially in Germany and Holland; but exchange difficulties may make these only temporary. Prices have been low of recent years, despite an improvement owing to the short crop of 1933, and it is to be feared that no marked improvement is likely. There is a severe competition (despite the 10 per cent. preference accorded to Cyprus carobs in the United Kingdom) from carob pro-

ducers in Crete and Portugal; the recently explored Continental markets are uncertain, while the prices of cattle-food commodities are likely to remain depressed owing to the number of alternative commodities (e.g. molasses) which are available.

Vines.—The growing of vines is the principal industry in the hill areas of the island, and the area under vines has been much extended of recent years. Little terracing was done in the early years, but in more recent times walls of stones have been built across the contours of hilly slopes to check soil waste, and in some places excellent terracing has been carried out. With the exception of one large company, the Cyprus Wine and Spirits Company, wine-making is carried on as a peasant industry, each grower converting his own production of grapes into wine. A beginning has, however, been made with the co-operative production of wine, and seven co-operative societies have been established and registered. Prices for wine so produced have been in excess of the prices realised from home-produced wines, and it is expected that further co-operative grouping for the production of wine will make gradual growth. A considerable part of the vine cultivations are devoted to the growing of grapes to make wine for local consumption, but exports of wine are of considerable importance. The following table shows the value of total wine exports during the last five years, together with the value of exports during the same period to the chief market, Egypt:

Year.	Total. £	Export to Egypt. £
1929	62,324	41,714
1930	51,736	40,791
1931	75,879	58,104
1932	71,727	53,139
1933	49,373	23,216

The serious decline shown in 1933 was due to the imposition by the Egyptian Government, in May of that year, of heavy protective tariffs against imported wine; and, unless it is possible to secure some relief from these duties, further exports to Egypt are likely to be severely limited.

Export to the United Kingdom is controlled by licence, with the object of securing the maintenance of a prescribed standard quality. Only one such licence has been issued

—to the British Cyprus Wine and Spirits Company—who thus have a monopoly of the export trade to England. Sir Ralph Oakden received a number of representations from wine exporters and from some producers against the system of licensing. In view, however, of the paramount necessity of maintaining the quality of the exports sent to the United Kingdom, he is of the opinion that the system should be maintained on the understanding that private individuals may be allowed to export up to a given quantity of wine, not for sale, on the authority of the Director of Agriculture. Exports to the United Kingdom (which enjoy a preference on the home market) have shown a steady increase in recent years, as will be seen from the following table :

Year.	Quantity. *Gallons.*	Value. £
1929	44,575	3,718
1930	87,192	6,176
1931	156,666	12,343
1932	185,752	14,881
1933	236,444	19,489

In addition to the export of wines there are also exports of vinegar (averaging £4,560 over the period 1929–33), of grape juice and must (averaging £6,498 over the same period), and considerable exports of fresh grapes and dried raisins, as shown in the following table :

Year.	Grapes. Quantity. *Cwts.*	Value. £	Raisins. Quantity. *Cwts.*	Value. £
1929	32,792	11,061	97,087	67,148
1930	29,220	9,026	103,149	73,138
1931	21,330	6,414	53,373	43,735
1932	13,078	4,061	62,354	33,235
1933	13,174	4,315	99,374	58,999

As a consequence of the difficulties experienced in the export of wine, particularly on account of the contraction of the Egyptian market, increased attention is now being given to the planting of table grapes and sultanas. Increasing quantities of cuttings of table grape varieties and sultanas are being issued by the Experimental Station at Saitta, whilst demonstrations in raisin-making are provided for, and growers are slowly adopting better methods of production.

The growers of vines have been reasonably prosperous

during the last three years and have not suffered to the same extent from drought and low prices as cereal and carob growers.

The immediate future of the wine market is, however, as explained above, uncertain owing to the restriction in markets, and must give rise to considerable anxiety. Sir Ralph Oakden considers that every effort should be made to secure, if possible, a reopening of the Egyptian market; if it were possible for Malta to accord preference to Cyprus wines and brandy over wines at present imported from Greece, this would give some relief to an industry likely to be hard pressed. The recent extension of the exports to the United Kingdom should be maintained without difficulty, and the growth of suitable table varieties of grapes and the production of dried fruit for export are clearly lines of development which should be encouraged in every way.

Potatoes.—These have in past years formed a valuable export crop, and, indeed, occupy second place in agricultural products exported. The average value of potato exports during the period 1929–33 was £90,866 per annum. In 1933, however, there was a marked fall in production and in export values. Only approximately one-half of the area devoted to this crop in 1929 was cultivated in potatoes in 1933. The area sown under a winter crop was limited by reason of lack of irrigation water, but the main cause of the reduction of production has been the very severe contraction of previously valuable markets in Greece and Egypt. The Palestine market has also been a valuable one, taking potatoes to the average value of £21,000 a year, but recently an increased tariff has been imposed on potato imports into Palestine with a view to encouraging Palestinean production, and this cannot be without serious effect on exports from Cyprus.

The following table shows the area sown, production and exports during the years 1929–33:

Year.	Area. *Donums.*	Production. *Cwts.*	Exports. *Cwts.*	Exports. £	Imports (seed). *Cwts.*	Imports (seed). £
1929	20,789	490,280	338,980	132,924	21,435	10,165
1930	16,523	358,193	344,075	95,352	14,658	5,789
1931	17,622	402,558	261,447	93,920	14,642	5,988
1932	19,355	442,864	308,455	85,800	13,651	6,036
1933	12,717	303,192	226,236	46,607	14,255	4,766

Attempts have been made to develop a trade with the United Kingdom, but this trade is faced with difficulties on account of the prevalence of the tuber moth in the island. The Ministry of Agriculture and Fisheries in the United Kingdom and the Department of Agriculture in Scotland are naturally most desirous of preventing the introduction of this pest, and in consequence demand not only plant-health certificates from the Cyprus Department of Agriculture but insist on thorough inspection of all consignments on arrival. It is possible that early consignments, which have been picked over before shipment and inspection, could find a remunerative market in the United Kingdom, but generally speaking it is anticipated that Cyprus would be better advised to test the Eastern markets. The possibilities of India and Ceylon are being explored, and some small consignments have secured remunerative returns. The finding of new markets is the problem governing the production of potatoes in Cyprus, and these are unlikely to be obtained and secured unless provision is made in the island itself for proper grading prior to export, and unless the requirements of any given market (e.g. whether it prefers round- to oval-shaped tubers) are carefully studied. Ceylon is a promising market, as its imports of potatoes amount to about 14,000 tons per annum ; and Indian markets should likewise offer possibilities. Production can be increased as markets are found, as the quality of the Cyprus potato is good and yields are generally satisfactory, especially if imported seed is used.

Cotton.—This is the main money crop grown in the plains during the summer months, but the area planted under this crop during past years has been greatly reduced owing to the scarcity of water for irrigation. Areas cultivated without irrigation have suffered severely during the past two years, and it is thought that the reduction of acreage has been due more to the unfavourable climatic conditions than to the relatively low world prices for cotton. Cotton prices improved during 1934, and a greater local interest was taken in the prospects of cotton production. A number of varieties are used, American upland, African and Iraq types being grown. It is reported

that there is a considerable mixture of types, and that in consequence only inferior prices are realised. The Agricultural Department has produced a promising selection from a Cyprus variety of cotton and its production is being gradually extended. A number of variety trials are also being carried out, and when high-yielding types suitable for the general conditions prevailing in the island have been adequately tested it is proposed that an effort should be made to secure adequate seed multiplication so that the present cultivation of mixed types shall be replaced with varieties true to type. It is only by this means that satisfactory cotton cultivation will be achieved and the growers obtain the full value from this summer crop. The lint is mainly exported, but about a half of the seed is used locally as stock feed.

The following table shows the production and exports of cotton during the past five years :

Year.	Production.		Exports.			
	Area.	Yield.	Cotton.		Seed.	
	Donums.	*Cwts.*	*Cwts.*	£	*Cwts.*	£
1929 . . .	33,566	41,906	12,569	55,457	7,079	2,829
1930 . . .	63,966	56,166	13,223	36,464	9,821	2,228
1931 . . .	33,903	34,103	14,357	33,118	21,762	4,040
1932 . . .	18,897	13,330	10,586	25,118	—	—
1933 . . .	14,387	10,872	4,378	11,724	1,456	327

The principal market for cotton is Greece.

Flax.—This crop is grown on dry lands and also under irrigation for the production of linseed and of fibre. The production and exports during the past five years have been as follows :

Year.	Production.			Exports.			
	Area.	Fibre.	Linseed.	Fibre.		Linseed.	
	Donums.	*Cwts.*	*Cwts.*	*Cwts.*	£	*Cwts.*	£
1929 .	5,587	3,189	8,793	1,438	1,494	12,008	10,227
1930 .	4,221	2,189	8,286	937	666	4,170	3,293
1931 .	8,109	2,171	14,185	1,223	1,228	5,440	2,387
1932 .	2,609	423	1,963	444	330	9,123	4,073
1933 .	6,096	4,611	7,651	453	229	8,024	4,810

It will be seen that most of the linseed is exported. On the other hand local industry absorbs the bulk of

the production of fibre, and the efforts which have been made by means of financial assistance from the Empire Marketing Board and the local Government have not resulted in increased production for export. It can only be concluded that the chances of increased production for export are therefore remote and that further expenditure in this direction cannot be justified. The increased cultivation of flax for the production of seed is, however, to be expected, and as animal husbandry methods in the island improve an increased local demand for linseed for the fattening of stock may be anticipated.

Tobacco.—The growing of tobacco is likely to become of increasing importance, although hitherto production has fluctuated considerably from year to year. Two types are cultivated: "Latakia" or dark fumigated leaf for pipe mixtures and yellow leaf for cigarettes. The following table shows (*a*) the area cultivated and production over the past five years of both types, (*b*) the exports of all types and (*c*) exports to the United Kingdom, which is the chief, almost the sole, market:

Year.	Production.			Exports.		Exports to the United Kingdom.	
	Area.	Fumigated leaf.	Yellow leaf.	Quantity.	Value.	Quantity.	Value.
	Donums.	*Cwts.*	*Cwts.*	*Cwts.*	£	*Cwts.*	£
1929 .	4,612	3,802	3,617	3,051	18,677	3,012	18,445
1930 .	2,288	1,346	1,249	3,479	23,679	2,937	19,383
1931 .	1,057	850	249	2,294	14,589	2,256	14,493
1932 .	1,317	1,632	98	2,378	8,014	2,218	7,684
1933 .	2,894	3,363	722	3,303	12,407	3,303	12,407

Export values improved during 1933 and the demands for growing licences in 1934 were greatly in excess of those of previous years. Quality is gradually improving and the demand in the United Kingdom for Cyprus tobacco is increasing. During 1933, a successful experiment in the growth and flue curing of Virginian was made by private enterprise, and it is anticipated that this trial will be continued. With attention to the maintenance and improvement of quality it is expected that the market for fumigated tobacco will be fully retained and that the market for cigarette tobacco will expand. Local consumption of Cyprus-grown tobacco is very small, as there

is a decided preference for tobacco imported from Greece and elsewhere. This almost complete dependence on oversea demands cannot be regarded as satisfactory, and detailed proposals are put forward in the Report with the object of making the use of Cyprus tobacco more attractive to local cigarette manufacturers. Proposals have recently been made whereby a commercial firm would be given for a period of five years the sole right of export of all yellow-leaf tobacco grown in the island, subject to the guarantee of a fixed price to the grower over that period, and to the exercise by the firm in question of the right of refusing to purchase tobacco deemed by an expert appointed by the Government to be unsuitable for export. If this proposal is accepted—and Sir Ralph Oakden believes it to be in the best interests of the Cyprus tobacco grower—it will, by guaranteeing for five years an export market for all but the poorest grades of tobacco, considerably reduce the necessity for securing increased local consumption of Cyprus-grown tobacco; but the general principle that such consumption should be increased remains sound and may conceivably be still more important if at the end of the five-year currency of the agreement it is not renewed, when the island might have largely increased areas under tobacco but no ready market for its produce.

Citrus.—Citrus fruits are of increasing importance, and represent one of the most hopeful avenues of development in the island. The following table shows the exports of oranges and lemons during the past five years:

Year.	Oranges.		Lemons.	
	No.	Value.	No.	Value.
		£		£
1929	13,009,961	40,168	2,665,190	2,746
1930	18,070,531	40,109	1,094,790	911
1931	21,638,000	43,270	2,497,000	1,926
1932	17,344,937	29,372	2,096,373	1,719
1933	20,266,424	34,498	3,112,715	2,554

The chief markets were originally Greece and Egypt, but in 1933 exports to Greece diminished almost to nothing and exports to Egypt, while still important, have also decreased considerably owing to duties recently imposed by the Egyptian Government. The United Kingdom is

now becoming the most important market. Exports have increased from £861 in 1929 to £10,955 in 1934. Cyprus oranges have the advantage of a 10 per cent. preference which is not shared by Palestine oranges, but one of the difficulties in extending United Kingdom exports has been the absence hitherto of direct and fast steamship lines. Values generally showed a relative fall in 1933, but they still leave a good margin of profit to the growers, and it is estimated that two acres of oranges provide adequately for the subsistence of a small-holder. The introduction of the Agricultural Produce Export Regulations during 1933 was an important step towards a satisfactory standard of quality and packing for exports. There were naturally some difficulties during the first year of the operation of these regulations, but these were satisfactorily overcome and there should now be nothing to hinder the steady improvement of standards of quality and consequent increased prices. Prices for fruit cannot be maintained in competitive markets unless attention is given to the standardisation of fruit exported, and to grading, marking and packing. There is much which still remains to be done, but, given whole-hearted support, the Department of Agriculture should be able to guide exporters and producers along lines which will inevitably be to their advantage. Given proper attention to marketing and the elimination of all inferior fruit, there is no reason why the citrus industry should not expand to considerable dimensions and become eventually one of the important agricultural industries of the Colony, if not the most important.

At present production is limited to certain areas, especially those near Famagusta and Lefka ; but there are considerable other areas eminently suited to citrus cultivation if water for irrigation is available and the necessary windbreaks established. Extension of the area under oranges (at present about 1,500 acres) has already begun ; near Limassol, in particular, the Cyprus-Palestine Plantations Company, Ltd., has acquired fairly extensive areas for the planting of citrus. It is estimated that in the Limassol district alone an area of 20,000 acres is available for development with citrus cultivation and that adequate

supplies of irrigation water should be readily procurable within a reasonable distance below ground-level.

The quality of the Cyprus orange has been well proved, and provided that bud-wood is taken from only first-class trees, a high-quality product can be assured if attention is given to standardisation of grading, packing and marking. Grapefruit cultivation is also feasible if first-class planting material is used. The Department of Agriculture has realised the importance of using such material and has recently decided to issue only budded plants—thereby ensuring a control over the quality of the planting material. This change of policy has resulted temporarily in some shortage of planting material, but within a year or two adequate supplies of budded plants ready for planting out should be available for meeting all the needs of small growers. Larger growers will naturally have to depend upon the production of their own supplies, and within the present year licences to import bud-wood under phytopathological inspection from Palestine have been granted in order that development may not be retarded. Certain small nurseries have been established for the supply of citrus planting materials, but it may be necessary to consider whether these should not be subject to licence and inspection by the Department of Agriculture, if the issue of inferior planting material is to be prevented.

A successful fruit industry depends so much upon uniformity of quality in its produce that regulation from the beginning has been shown in all fruit-growing countries to be not only desirable but essential to the welfare of the industry. This is particularly the case as competition increases. When Cyprus comes into the market with considerable supplies of citrus fruit, competition will be excessively keen, but it is unlikely that there will be any great difficulty in the marketing in Europe of increasing quantities of citrus fruit from Cyprus, and there are possibilities of further markets in the East. Exporters naturally cannot expect, having regard to increased production elsewhere, particularly in Palestine, that high prices will continue indefinitely, but there is at present a considerable margin between the costs of production and

the actual amount realised, so that growers should have a reasonable assurance of satisfactory returns. As already mentioned, Cyprus has the advantage over Palestine and other competing countries (e.g. Spain) of Imperial Preference, and there is a growing demand for oranges of the type which is grown in the Colony. There is also plenty of room in the United Kingdom market for additional supplies of Empire-grown grapefruit, and provided that only the seedless varieties are grown and attention is given to the shipping of clean, well-graded fruit, supplies should find a ready market.

Other Fruits.—There is an extensive production and local consumption of many other kinds of fruit—apricots, cherries, grapes, peaches, plums, quinces, melons and figs. Almonds to the value of £10,000 are exported, chiefly to the United Kingdom, and increased planting is taking place. Demands for grafting material from the Majorcan and South African varieties introduced in recent years and from selected local varieties, are increasing, and the general prospects are promising. There is also a large demand for planting material of deciduous fruits for the extension of plantings in the hills. There are hopeful prospects of developing a small export trade to Palestine. Exports of pomegranates have fallen from £22,259 in 1929 to £5,318 in 1932, owing to tariff restrictions in Egypt, which has been for years, and still remains, practically the only market. There is little hope of any improvement in the position, and a good deal of land originally under pomegranates is now being utilised for other products.

Olives.—The most important crop for local consumption next to cereals is the olive, which forms an essential part of the staple food of the population. Olives are produced in all districts, but only to a limited extent on the central plain. Crops vary very much from year to year. Thus in 1931 the crop was estimated at 14,800 tons, but, as a result of the severe drought, this was followed by crops of less than one-tenth of that quantity in 1932–33. It is usually necessary to import both olives and olive oil, although at the same time there is in normal years a small "cross-export." The following table shows the situation in regard to olive production :

Year.	Production.		Imports.		Exports.
	Olives.	Olive oil.	Olives.	Olive oil.	Olive oil.
	Cwts.	*Cwts.*	*Cwts.*	*Cwts.*	*Cwts.*
1929	219,095	46,793	1,264	376	175
1930	31,721	5,869	802	3,666	239
1931	295,868	49,824	1,395	609	94
1932	26,075	40,572	946	274	358
1933	36,240	3,774	3,963	2,039	—

Sir Ralph Oakden considers that every encouragement possible should be given to the extension of olive growing: there is clearly no reason why the colony should not be wholly self-supporting in respect of olives. Improved methods of cultivation and pruning are necessary—a matter to which the Department of Agriculture is devoting attention—and in addition every opportunity should be given to cultivators to obtain wild olive trees from Forest reserves (where there is said to be an abundant supply) at the lowest possible rate. These could be readily transplanted and subsequently grafted with improved types. The Conservator of Forests has recently reduced the charges for such trees, but these might well be further reduced in the interests of olive growing. The suggestion was frequently made that permission should be given to villagers to graft wild olive trees *in situ*, i.e., in the Crown Forests. While the possibility of arranging for this might be further explored, it is recognised that there are serious objections to any such course and that any alteration of policy in this regard would need careful consideration.

Minor Crops.—Vegetables are grown mainly for local consumption, the demands of which are likely to increase if the tourist trade develops. There is an export trade in onions, the average value of which is approximately £5,000 a year, and, provided that Cyprus is able to produce straw-coloured onions of good keeping qualities, exports to the United Kingdom should increase, particularly in view of the 10 per cent. preference accorded in that market. Other agricultural products of minor but appreciable importance are sumac, cumin seed and aniseed. Sumac exports have averaged just over £6,000 since 1929, while, despite a serious fall in prices, exports of cumin seed were worth £8,341 in 1933.

Silk.—The silk industry is experiencing considerable difficulties as the result of prevailing low prices. The following table shows the exports of raw silk and silk waste since 1929:

Year.	Raw silk.		Silk waste.	
	Quantity.	Value.	Quantity.	Value.
	Cwts.	£	*Cwts.*	£
1929	215	24,632	157	1,354
1930	139	17,163	110	662
1931	79	9,051	26	78
1932	77	3,641	50	191
1933	204	9,741	86	364

A Silk Filature was established near Paphos in 1926, but has operated under disadvantages from the start, though protected by the imposition in 1931 of an export duty on silk cocoons. The continuous fall in the price of raw silk (from 28*s*. a lb. in 1926 to 9*s*. in 1934) has meant that the filature has been unable to pay a price for cocoons high enough to enable it to obtain an adequate quantity from the peasant producers. Thus it is estimated that in 1933, when the filature was able to pay 9 cp. per oke for cocoons, it obtained only one-third of the total production; the balance was kept by the villagers for reeling into coarse silk in the villages. In 1934 the highest price which the filature could afford to pay would be 5 cp. per oke, and it is reasonably certain that at this price the producer would either be forced out of production or would not sell his cocoons to the filature. In the circumstances, the proprietors felt that they had no alternative (failing any alteration to their advantage of the tariff in the United Kingdom) but to ask Government for a subsidy of £2,000 to enable them to pay a price of 9 cp. an oke or to cease altogether operations which have been unprofitable for years. The matter was referred to Sir Ralph Oakden for advice, but having regard to the comparatively high proportion of the subsidy suggested to the value of the industry, and to the uncertain prospects of any rapid recovery in silk prices, he did not feel justified in recommending the payment of a subsidy. It is to be feared, therefore, that the silk industry will shrink to a cottage industry on a small scale.

Livestock.—The importance of the stock industry, particularly to the cereal-growing areas, is not, as yet, generally recognised. It is of very considerable value in that not only does it satisfy local consumption but that even in a year of drought and low prices like 1933 the value of exports of stock and animal products totalled just under £110,000, nearly one-seventh of the Colony's total exports.

A census of animals is carried out biennially, and at the census of 1932 the number of animals was as follows:

Horses	4,612	Cattle	43,604
Mules	10,273	Sheep	304,437
Donkeys	53,738	Goats	224,030
Camels	1,298	Swine	26,896

The values of exports of livestock and animal products during the past five years have annually averaged as follows:

Animals not for food	£37,330 (chiefly mules to Egypt, Palestine and Syria).
Animals for food	£40,378 (chiefly oxen to Palestine).
Cheese	£17,250 (chiefly to Egypt).
Wool	£12,697 (chiefly to France).
Hides and skins	£10,104 (chiefly to France and Italy).

Compared with these average figures, the exports for 1933 amounted to:

Animals not for food	£36,453
Animals for food	£27,144
Cheese	£15,586
Wool	£16,581
Hides and skins	£14,826

Dairy products also constitute an important, if not the most important, item of diet of the Cyprus rural community. They form the main, and often the sole, protein portion of the diet. Fresh milk is produced almost exclusively for supply to the towns, the rural population depending mainly on cheese and sour-milk products. It is estimated that the value of the cheese consumed locally averaged £66,596 per annum during the five-year period 1929–33, and that the value in 1933, when prices were lower than usual, amounted to £45,516. Cheese is made from the milk of sheep and to a lesser extent from the milk of goats. Export quantities have been well maintained in

recent years despite the fact that prices have declined. There is also a well-maintained demand in neighbouring countries for Cyprus-bred mules, and in Palestine and Egypt for livestock. This export of livestock has shown considerable increase in numbers since 1930, when compulsory detention at the ports for a minimum period of 24 hours prior to shipment and the issue of a certificate of health in regard to each consignment was inaugurated. There has been a falling-off in the market in Egypt, but this has been more than compensated by the increasing market in Palestine, where the quality of Cyprus livestock is appreciated.

The cattle of Cyprus consist of two distinct types—namely the heavier Messaoria breed and the smaller Paphos breed adaptable for the hills. Cattle are employed in addition to donkeys and mules for draught purposes, and of the several importations of English breeds for purposes of stock improvement the Devon is reported to have been the most successful.

Stock have suffered severely during the past three years owing to the shortage of grazing and forage. In many areas there has also been a shortage of water as a result of the drying-up of wells. It is customary for animals to be grazed on the lands of their owners during the winter, but, in the summer, large flocks of sheep and goats, entrusted to shepherds, are common, and graze on waste land and on the stubble of the harvested fields. There is comparatively little hand-feeding. The enfeebled condition of stock owing to the drought led to an increased susceptibility to disease, and an outbreak of sheep- and goat-pox was serious. In some flocks deaths numbered 30 per cent. of the flock. Anthrax is still the most serious disease, but owing to a systematic and successful campaign of vaccination conducted by the Veterinary Section of the Agricultural Department (vaccinations rose from 3,219 in 1923 to 475,564 in 1933), losses from the disease have been very greatly reduced. The mortality in 1933 was 629.

It is impossible to anticipate any marked improvement in the prices for cereals within the next few years, and, that being so, it is probable that their conversion into food through animals may, on the whole, be more profitable than

direct consumption. Having regard to this fact, and to the very considerable value of the livestock industry to the island, it is most desirable that every encouragement should be given to the development of the industry; and the proposals which have recently been elaborated by the Director of Agriculture are sound and warrant the fullest support. These proposals envisage further encouragement of and assistance to mule breeding, and improvement of the cattle, sheep and swine by the further introduction of selected pedigree animals from abroad. They are further discussed in the section of the Report dealing with the work of the Department of Agriculture, in which section it is recommended that an application should be made to the Colonial Development Fund for financial assistance towards the cost. Such improvements of the stock of the country are, however, unlikely to be maintained unless better methods of animal husbandry are evolved and greater attention is given to feeding. An export market in livestock is unlikely to be maintained for any length of time unless stall-feeding becomes more general, and the milk yield of sheep and goats is unlikely to be increased unless the present methods of husbandry are improved and a certain amount of stall-feeding given.

For horses, mules, donkeys and cattle adequate supplies of dry straw, cereals, vetches, peas and beans are available in normal years, but during the summer months there is always a shortage of green fodder. Some maize is being grown for fodder, but greater use could probably be made, as is done in Malta and in South Africa, of the cactus, which grows well in the island. Similarly, the production of irrigated crops of lucerne should be encouraged and, if necessary, assisted during the next few years.

Forestry

The nominal area of forest in the island is 633 square miles, or about 405,000 acres, but this total includes a considerable area of scrub and waste land.

The commercial exploitation of the forests has hitherto been confined to the Forest Department (with the exception of permits to cut timber, to burn charcoal and to gather fuel, which are granted to villagers in respect of

small quantities) with uniformly disappointing results. The sale of all kinds of forest produce (including building material and fuel) realised £9,778 in 1932 and £8,727 in 1933—amounts which did not nearly cover the cost of the commercial organisation of the Forest Department. The following volumes of timber and fuel were extracted from the State Forests in 1932 and 1933 :

	1932. Cubic feet.	1933. Cubic feet.
Timber. . . .	281,442	235,473
Fuel	1,373,120	537,882

Sufficient fuel is available for the needs of the Colony, but the bulk of the timber has to be imported, as it has apparently hitherto proved impossible, despite lavish expenditure, to evolve any satisfactory method of seasoning Cyprus timber (though Anatolian timber can be seasoned without difficulty). Timber is imported yearly to an average value of £45,000.

The Cyprus forests are mostly light forests of pine, which could not, without grave risk of denuding the hill-sides, stand the heavy and continuous felling which would be necessary to make the extraction of timber a commercial success, especially at the present low prices. It is doubted if the forests can do more, at any rate at present, than form a fuel supply for the island.

Mining

Mining was an important activity in the island during Phœnician and Roman times, then lapsed for centuries, and has reassumed its importance during the last thirty years. It now plays a very significant part in the island's economic life, as is shown clearly in the following general statement :

Year.	Total value of exports.	Mining products exported.	Average annual amount paid in wages.[1]	Average daily number employed.
	£	£	£	
1929 . . .	1,582,083	606,328	290,160	6,098
1930 . . .	1,145,466	385,266	190,950	3,523
1931 . . .	983,860	278,101	85,464	1,960
1932 . . .	857,301	207,230	67,230	1,690
1933 . . .	810,976	258,082	91,140	2,310

[1] *To Cypriot staff only.*

Two mining enterprises transcend all others in importance—the working of the extensive deposits of cupriferous pyrites at Skouriotissa and Mavrovouni by the Cyprus Mines Corporation, and of the asbestos products at Amiandos by the Cyprus and General Asbestos Company.

The Cyprus Mines Corporation began operations at the Skouriotissa mine (which is one of the ancient mines of Soli) in 1919, and the first cargoes were shipped in 1922. The ore is sent to a dressing plant at Xeros (with a capacity of 1,200 tons a day) where it is screened and classified prior to export. It is from this mine that the Corporation have hitherto drawn the bulk of their ore, the figures being :

ORE MINED—PYRITES

Year.	Skouriotissa Mine.	Mavrovouni Mine.	Value of combined exports.
	Tons.	*Tons.*	£
1929	288,110	4,320	279,483
1930	233,435	22,845	248,441
1931	161,839	30,676	194,750
1932	70,923	88,935	166,552
1933	200,124	11,370	195,779

The Corporation contemplate, however, that after 1935 the Skouriotissa mine will be closed down and all work will be concentrated at Mavrovouni (where operations began in 1924), since the pyrites ore at Mavrovouni is considerably richer in its copper content and lends itself more readily to treatment locally.

In August 1933 the Corporation began the construction of a new Ore Treatment Plant (estimated to cost £250,000) at Xeros and it is probable that in future copper concentrates and not pyrites will be the main export. The expenditure on this construction work has done much to provide employment and to some extent to counterbalance the curtailment of the Company's other activities.

There is no local consumption of ore, which is exported mainly to Italy, Germany, Holland and the United Kingdom, and the Corporation has accordingly felt the full force of the general economic vicissitudes of recent years and the fall in demand and prices. The value of exports, which stood at £279,483 in 1929, dropped to £166,552 in 1932, but recovered somewhat in 1933, to reach

a total of £195,779. In 1931 the Skouriotissa mine was closed for some six months, and at the end of December 1932 the Mavrovouni mine was also closed pending a sustained increase in the demand for copper and a general improvement in market conditions. Even, however, during the last two years the Corporation has employed an average daily number of 1,350 Cypriots and has paid an average of £5,000 a month in wages. The average daily number employed is now much higher (see p. 381).

These mines are among the island's most valuable assets, and they are being exploited in the most efficient way possible by a first-class organisation. It is only to be hoped that conditions will so far improve as to allow the Corporation to resume full activities. Any assistance which it may be possible for Government to make to that end should be readily afforded.

Statistics relating to the operations of the Cyprus Mines Corporation, as well as of the other mining concerns, during 1934 and the first half of 1935, are given in this BULLETIN (1934, **32**, 467; 1935, **33**, 76, 381).

The Cyprus and General Asbestos Company (which is the successor of several earlier concessionaires) hold two leases for the excavation and extraction of the very large deposits of asbestos near Amiandos in the Troodos hills. The asbestos (which is short fibre) is quarried, treated in primary mills, finished in a fibre mill and then sent down by cable-way to Limassol for export. Owing to the position of the mine, work is only possible for the six summer months. The Company were producing an annually increasing amount of asbestos up to 1929, when the economic depression and severe competition affected their activities very seriously. This is shown in the following table:

Year.	Finished asbestos exported.		Average daily number employed.	Average monthly wage payments.
	Quantity.	Value.		
	Tons.	£		£
1929	13,796	292,971	3,537	12,861
1930	5,400	116,092	994	4,986
1931	3,575	66,381	235	935
1932	1,600	27,214	262	862
1933	4,604	44,088	713	1,616

As will be seen from the above statement the Company was brought to a very low level in 1932 owing to the factors already mentioned ; and, accordingly, the Government decided temporarily to reduce the royalty payable on asbestos to a merely nominal figure. This concession enabled the Company to compete in countries other than their regular markets (the United Kingdom, Germany and Italy) and brought about some revival during 1933, which has continued during 1934. During the first six months of 1934, 3,570 tons of asbestos were exported at a value of £34,068, as against 1,158 tons to the value of £16,390 during the corresponding period in 1933. The reduced royalty rate was extended to 1934, and Sir Ralph Oakden recommended its continuance, if necessary, during 1935, having regard to the importance of this enterprise as an employer of labour.

Other mining activities are on a much smaller scale. The Cyprus Sulphur and Copper Company, Limited, operated until June 1932 a small pyrites mine at Lymni of low-grade ore by heap leaching, but all work has now been suspended. The Cyprus Chrome Company hold a lease for the development of chromite deposits on the northern slopes of Troodos, but there have been no exports for the last three years. Gypsum is extensively quarried for local use and for export. There are over 200 quarries, most of them operating on a very small scale. Exports only average about £600 in annual value, but Government has recently waived all royalty charges with the object of stimulating export. Terra umbra forms a more important export, especially to the United Kingdom and the United States of America, the annual value averaging over £7,000 during the last four years. It is of excellent quality, but the mining is primitive and inefficient.

Salt, a monopoly of Government, is collected from salt lakes near Larnaca. There was originally a considerable export trade, but this has entirely disappeared and there seems no prospect of its revival.

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published in this BULLETIN are given below, to which are added a selection of other works on the subject.

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NOTES

Retirement of Dr. Ernest Goulding, D.Sc., F.I.C., F.C.S.—Dr. Goulding, Vice-Principal of the Plant and Animal Products Department of the Imperial Institute, has retired on reaching the age limit. His connection with the Institute extended over a period of thirty-nine years, and during that time he took an important part in the Institute's scientific and technical work on Empire raw materials, as regards both laboratory investigations and intelligence services. Since 1923 he was also responsible for the editing of this BULLETIN.

Dr. Goulding was a recognised authority on fibres, and his work on this subject has covered a wide diversity of fibrous materials of Empire origin. Reference may be made

to the leading part which he took in the early investigations of Empire-grown cottons carried out at the Imperial Institute in the pioneer stages of cotton cultivation in the Colonies. He acted as Secretary to the Imperial Institute Advisory Committee on Vegetable Fibres from its formation in 1926, and in this capacity undertook important work on the extension of the use of Empire-grown fibres, both for marine cordage and for other purposes.

Dr. Goulding's activities brought him into contact with many technical experts, official and unofficial, from all parts of the Empire, who will share the regrets felt by his colleagues at the termination of his long service at the Imperial Institute.

The Experimental Cultivation of Tung Trees in South Africa.—At the instigation of the Imperial Institute Sub-Committee on Tung Oil, supplies of Tung seed were distributed several years ago to countries of the Empire in which climatic conditions appeared suitable to the growth of the tree. This was done with a view to determining by means of cultivation trials the lands in which the crop might be successfully grown on a commercial scale. The results of many of these trials have already been summarised in this BULLETIN (1932, **30**, 24). More recently, experiments made in the Union of South Africa have been described in a Bulletin issued by the Department of Agriculture and Forestry, Union of South Africa, and entitled "Tung-nut Growing," by H. van Elden, M.Sc., and E. P. Phillips, M.A., D.Sc. (*Bulletin No.* 140, *Plant Industry Series*, No. 1, 1935).

With a view to procuring complete information for the purpose of this *Bulletin*, a questionnaire was circulated by the Division of Plant Industry, Pretoria, to all those who had made application to it for some of the seed sent out by the Sub-Committee for distribution. Although the response to the enquiries was not as full as desired, the particulars received were nevertheless considered adequate for the object in view.

The areas in which Tung trees are being cultivated in the Union lie on the coastal belt of Natal and Zululand, in parts of Swaziland and in the north-eastern portion of the Transvaal. In addition, an experimental trial was made at Uitenhage, Cape Province, while at the Rhodes Fruit Farm at Groot Drakenstein there is a fairly extensive planting and the trees appear to respond well to the local conditions. In the Union it is estimated that at least 203 acres are under the crop and that the number of trees is well over 20,000. Most of the trees are from one

to four years old, but there are a number at least six years old.

Tung trees seem to succeed on a variety of soils, provided the drainage is good. From reports received, the best results would appear to have been obtained on a deep sandy loam in areas with an average annual rainfall of at least 30 in. and where only slight frosts occur. Even in localities where severe frosts have been experienced, however, the trees have grown and recovered from the effects of the cold.

Considerable variations have been noticed in the trees grown from seed in South Africa. At the Sub-tropical Horticultural Research Station, Nelspruit, several distinct types varying in habit of growth, leaf character and fruit have been recognised. The propagation of desirable types has been generally made by planting seed of good parent trees, but it is expected that better results will be obtained by budding. Experiments in budding at Nelspruit have been successfully carried out. Planting the seed direct in nursery rows is recommended. On transplanting the seedlings, 25 ft. by 25 ft. has been found a suitable spacing. The most economic fertiliser to apply to the plantation has not yet been determined. Kraal manure applied at the time of transplanting the nursery trees to their permanent position has given beneficial results. Sunn hemp as a cover crop has been tried and has proved suitable.

The age at which seedlings come into bearing varies considerably, but generally it may be expected that trees will bear at four years, but will not bear heavily until they are over six years old. At the Rhodes Fruit Farm, Groet Drakenstein, some trees five years old, planted under orchard conditions, are bearing on the average 120 fruits per tree. At Pilgrim's Rest, Transvaal, fruits were produced on a few trees three and a half years old, and about 400 trees four and a half years old bore seven or eight fruits each. At Stegi, Swaziland, it was observed that over 3,000 trees two years old were nearly all in flower, and 70 lb. of fruit had already been gathered from them. Samples of Tung seed grown at Port Durnford, Zululand, and at Pilgrim's Rest, Transvaal, have been received at the Imperial Institute, and on examination were found to contain a normal percentage of oil of satisfactory quality (see this BULLETIN, 1932, **30**, 276).

The trials so far carried out in the Union indicate that there are suitable areas in South Africa where Tung trees will grow, but it still remains to be shown whether their

cultivation on a commercial scale will be a remunerative enterprise.

Ilmenite-Monazite Sands from Travancore.—Some years ago the Director of Industries, Travancore, forwarded to the Imperial Institute a number of samples of beach sand for examination in regard to their monazite content.

The sands, which had been collected from different localities on the sea coast of Travancore, were sent in response to a suggestion from the Imperial Institute that owing to variations in the amounts of thoria found in samples of Travancore monazite previously examined, it would be of interest to analyse authentic samples from deposits not then worked commercially.

It was found on examination that many of the samples contained considerable quantities of ilmenite, and in view of the increasing interest which is now being taken in Empire occurrences of this mineral, the results obtained in the mineralogical and chemical analyses of these samples are given below.

The majority of the samples were found to consist chiefly of ilmenite, with smaller amounts of zircon, garnet, quartz, enstatite, monazite and rutile. The amounts of (*a*) monazite, and (*b*) ilmenite and garnet, were determined, with the results given in the table on page 356.

In most samples the monazite was the most finely grained constituent of the sands, whilst the garnet and quartz (and sometimes zircon) were the coarsest.

Some of the sands contained appreciable amounts of enstatite ; in No. 2, for example, the non-magnetic portion, which formed about 25·5 per cent. of the sand, consisted of about 40 per cent. of quartz, 30 per cent. of enstatite and 30 per cent. of zircon and rutile.

Although the demand and consequently the interest in monazite sand has lessened owing to the decreasing demand for thoria minerals, it may be of interest to record here the results obtained on the analysis of pure monazites separated from a number of the crude sands.

Sample number.	Thoria in concentrate.	Sample number.	Thoria in concentrate.
	Per cent.		*Per cent.*
10	8·30	29	8·01
11	8·46	31	8·60
17	7·44	32	8·18
20	6·57	36	9·23
21	7·96	37	9·24
26	8·54	38	8·68
27	8·09		

At the present time there is a steady demand for ilmenite concentrates for use in the manufacture of

titanium-white pigment, the world's production of the mineral in 1934, so far as statistics are available, being about 60,000–70,000 tons. The chief sources of commercial supplies are Travancore, Norway and Egypt.

Buyers usually prefer a concentrate carrying not less than 50 per cent. of titanium dioxide, and the presence of chromium or vanadium is regarded, by some, as objectionable.

ILMENITE-MONAZITE SANDS FROM TRAVANCORE.

Locality.	Latitude.	Longitude.	Composition of sand.	
			Monazite.	Ilmenite and Garnet.
			Per cent.	*Per cent.*
1. Kochutura, north of Kayamkulam bar	76° 27′ E.	9° 9′ N.	(*a*)	79·8
2. Kayamkulam bar	one mile south on the beach		(*a*)	74·3
4. Aliyakkal, west of church	76° 28′ E.	9° 7′ N.	(*a*)	82·2
7. Ponmana, north of Chavara village	76° 31′ E.	9° 1′ N.	(*a*)	79·2
8. Kolithottam, west of church	76° 31′ E.	9° 0′ N.	(*a*)	82·0
5. Aliyakkal, south of church	near 76° 28′ E.	9° 7′ N.	0·5	75·0
28. Kottilpad	77° 16′ E.	8° 10′ N.	0·6	66·8
30. Manavalakurichi, near the monazite factory	77° 18′ E.	8° 9′ N.	0·9	85·2
9. Chavara Sand Dune, 48 m. 2 fur. on the canal	76° 32′ E.	8° 59′ N.	1·0	69·8
33. Kovakulam	77° 32′ E.	8° 5′ N.	1·0	94·6
34. Cape Comorin	77° 33′ E.	8° 4′ N.	1·5	94·9
6. Panakkada, near the temple	76° 29′ E.	9° 6′ N.	2·0	78·0
35. Cape Comorin	near 77° 33′ E.	8° 4′ N.	2·5	93·5
22. Varkala	near 76° 43′ E.	8° 44′ N.	2·8	76·6
25. Kizhmidalam	76° 13′ E.	8° 12′ N.	2·8	83·4
29. Pudur	77° 17′ E.	8° 10′ N.	3·1	77·0
26. Kurumbantura	77° 14′ E.	8° 11′ N.	3·3	77·8
31. Manavalakurichi, Mouth of Valliar River	77° 18′ E.	8° 8′ N.	3·3	83·1
38. Leepuram (near lighthouse)	77° 33′ E.	8° 6′ N.	4·6	80·1
20. Tiruvellauram	76° 33′ E.	8° 54′ N.	5·0	67·1
21. Varkala	76° 43′ E.	8° 44′ N.	6·0	71·5
36. Cape Comorin	77° 33′ E.	8° 5′ N.	6·3	82·0
10. Seventh milestone—Quilon to Chavara road	76° 32′ E.	8° 58′ N.	6·4	68·8
32. Muttam	77° 19′ E.	8° 8′ N.	7·3	77·0
17. Nindakara, south of bar	76° 33′ E.	8° 56′ N.	12·9	60·2
27. Kodimuna	77° 15′ E.	8° 11′ N.	16·0	63·2
37. Leepuram (Muttamtura)	77° 34′ E.	8° 5′ N.	19·9	65·4
11. Nindakara, north of bar	76° 32′ E.	8° 56′ N.	33·7	43·9

(*a*) *Less than* 0·2 *per cent. in these five cases.*

A New Mineral Research Laboratory in South Africa.—A sum of £6,000 was placed on the estimates of the Mines

Department, Union of South Africa, for 1934-35, for the establishment, in conjunction with the University of the Witwatersrand, of a Minerals Research Laboratory. It has been arranged that the University provides the site and buildings, while the Mines Department meets the expenditure on staff and equipment. A committee was appointed in April 1934 to advise on all matters connected with the establishment, administration and work of the laboratory, Professor G. H. Stanley (Professor of Metallurgy, University of the Witwatersrand) being appointed part-time Director.

From the first annual report, which has just been published as annexure B of the Annual Report for 1934 of the Government Mining Engineer, Union of South Africa, it is learned that the first section, consisting of a staff analytical and assay laboratory housed in the present Metallurgical Department of the University, was completed at the end of June 1934. A further laboratory for testing methods of ore treatment was completed early in 1935.

The investigations carried out included the treatment of plumasite or corundum-bearing rock from the Northern Transvaal, apatite concentrates, andalusite sand, gypsum and " Black Reef " gold ore.

The investigations showed that it was usually possible to obtain good recoveries of high-grade corundum from the plumasite by careful gravity concentration supplemented by magnetic concentration for cleaning. The biotite mica could generally be removed in this way or its removal effected by calcination of the concentrate at a red heat and re-tabling.

A considerable amount of experimental work was carried out with a view to increasing the " citrate-soluble " phosphate in apatite concentrates, such as those from Palabora recently described by S. J. Shand and A. L. du Toit. The powdered material, known as " Phosmeal," is a fluor-apatite containing 10·55 per cent. of silica (SiO_2) and 31·32 per cent. of phosphoric anhydride (P_2O_5), but, even after re-grinding, the citrate solubility is still extremely low, varying from 0·67 to 1·62 per cent.

It was found that destruction of the crystal structure of the apatite by fusion, either with fluxes or alone, resulted in greatly increased solubility. An initial experiment of projecting a fine stream of Phosmeal dust into an oxy-coal-gas flame, resulting in very brief but complete fusion of the material, gave a sample which was completely soluble in citric acid. This promising line of research is being followed up on a larger scale.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

Insect Pests

Locusts

Nigeria.—Mr. F. S. Golding, Senior Entomologist, in his report on the work of the Entomological Section, Department of Agriculture, for January to June 1935, gives an account of locust research carried out during the period.

On April 23 Mr. Golding joined a French locust research mission at Fort Lamy. Between April 26 and May 10 an examination was made of the southern shore of Lake Chad lying to the east of the Chari River. From May 17 to 20 he and one of the members of the French mission descended the Chari from Fort Lamy to Dabilda, a village not far from the delta. A survey was then carried out of the shore between Dabilda and the Nigerian-French Cameroons frontier. Not a single specimen of the Red Locust, *Nomadacris septemfasciata* Serv., was seen, and it seems certain that the ecological conditions in French Cameroons and French Chad (as far as the south-eastern corner of the lake) are unsuitable for that species. It had previously been thought that the Kalkala outbreak centre was merely the western fringe of a larger area extending eastwards into French territory.

Only three specimens of the solitary phase of the Tropical Migratory Locust, *Locusta migratoria migratorioides* R. and F., were found in the course of the survey. Most of the area examined is well wooded and few suitable habitats were seen.

From May 27 to June 1 the survey was continued westwards to Kalkala. Only ten adults of *Nomadacris* were seen. Three specimens captured were all extreme *phasis solitaria*. The 1934–35 flooding of Chad was exceptionally extensive and resulted in some of the normal winter habitats becoming unsuitable. The Carmine Bee-eaters were still present in very large numbers in the Kalkala region and were observed to be preying on the few *Nomadacris* that were disturbed from a patch of *Imperata* by setting fire to the grass. The number of Acrididæ was very markedly less than in 1933, and some species, which were abundant two years ago, appeared to be completely absent.

The analysis of swarm reports and meteorological data was continued. Cage experiments, designed to provide information concerning the life histories of *L.m. migratorioides* and *Zonocerus variegatus* L., are in progress.

BEVERAGES

Cocoa

Gold Coast.—The Director of Agriculture has furnished the following report on investigations on cocoa conducted during the period July to December 1934.

(*a*) *Size of Beans.*—The objects of these investigations were explained in the previous report (this BULLETIN, 1934, **32**, 439). The following comparative figures for the latter half of the past three years serve to support the statement made by the Department in 1932 that there was no indication of progressive decrease in size of beans owing to senility of the trees.

MONTHLY MEANS OF THE NUMBER OF BEANS PER 14 CUB. IN. IN ALL SHIPMENTS OF COCOA

Month.	1932.	1933.	1934.
July	139·9	138·7	141·7
August	136·1	139·8	140·2
September	128·9	135·5	132·5
October	129·6	125·4	122·4
November	132·0	123·3	122·0
December	134·2	123·0	123·2

(*b*) *Cocoa Bean Moth, Ephestia cautella.*—Further work on this pest is considered to be necessary, and will be aimed at testing the effect of heat on all stages of development, and the degree of attraction of adult moths to light. Investigations into the sources of infestation are being taken up by the British Association of Research for the Cocoa, Chocolate, Sugar Confectionery and Jam Trades, and material for the work is being supplied by the Department.

(*c*) *Co-operative Society Cocoa.*—The high standard of purity, which was set by the Department when this movement was founded, has been well maintained during the half-year under review. The major crop is still in process of preparation, so that details for each group of societies are not yet complete, but the weighted mean purity for all cocoa sold during the months July–December 1934 was 96·8, sales during the period amounting to 2,011 tons.

Nigeria.—The report of the Botanical Section, Southern Provinces, for January to June 1935, contains the following statements relating to cocoa investigations (by Mr.

O. J. Voelcker) and experimental control of black-pod diseases (by Mr. J. West).

Cocoa Investigations.—Experiments were conducted in 1934 to ascertain the effect of the rate of drying of cocoa beans after fermentation. It was hoped that slow drying would prevent, to a large extent, the shrivelling of the skin which is common in Nigerian cocoa. After fermentation one sample was dried in the sun on trays in the normal manner, being exposed thus for seven to eight hours each day. Another sample was covered with a single layer of palm leaves laid directly on the beans. The same leaves were used each day and on wilting allowed an increasing amount of sunshine to penetrate. A third sample received direct sunlight for three hours a day and was then covered with a tarpaulin. In both these latter treatments, the cocoa received full sun after four days to complete drying. The experiment was repeated three weeks later.

There was little to choose in external appearance between the two slower dried samples of beans, which showed only slightly less shrivelling than the control. This was reflected in volumetric determinations of bean size, which were remarkably similar for all treatments. Messrs. Cadbury Bros., to whom samples were sent, very kindly carried out exhaustive tests, and their opinion that the differences would not influence the price, has settled the point in question.

An investigation of the germination of cocoa beans was also carried out. Normally, cocoa beans germinate very readily, and a high percentage of strong seedlings can be expected from seed sown. During 1935, however, seed sown in January and February either failed entirely to germinate or, if germination took place, it did so after fourteen instead of six to seven days and gave rise to sickly seedlings. A number died shortly after the radicle had penetrated the seed coat. As sowings were made both in baskets and directly in the ground at four agricultural stations in Southern Nigeria with similar results at each, bad nursery management or peculiar soil factors can be ruled out as causes of germination failure. Moreover, the beans when planted appeared perfectly healthy and were taken from pods with no signs of pod disease. It is suggested that the cause was due to the low temperature which accompanied a severe spell of harmattan at the end of December 1934, when the pods were reaching maturity on the trees. The minimum screen temperature reached was 52° F. The point is of importance at Ibadan, where selection work on cocoa is undertaken. Cocoa flowers should be pollin-

ated not later than the first week in July, so as to obtain seed for planting before strong harmattan occurs, which can generally be expected at the end of December.

Experimental Control of Black-pod Diseases.—The experiments at Ajia (see this BULLETIN, 1934, 32, 443) were laid down in March 1931, and the four successive main crops which have been harvested since then express, in some measure at least, the results which are likely to follow the adoption of the various methods which have been tried. It must be remembered that the object of these experiments is to evolve control measures which will reduce the incidence of Black Pod to reasonable limits and which, at the same time, will prove acceptable to the Nigerian farmer.

Brief details of the plots are given in Table 1.

TABLE 1. AJIA PLOTS: DETAILS

Plot.	Acreage.	Treatment.
I	0·34	Thinned out and pruned—Bordeaux mixture spray.
	0·25	Control—untreated.
II	0·21	Thinned out and pruned—Copper dust.
	0·20	Control—untreated.
III	0·47	Thinned out and pruned—Sulphur dust.
	0·34	Control—untreated.
IV	0·89	Thinned out and pruned—All dead pods removed.
	0·78	Control—untreated.

In March 1931, the treated portions of each plot were thinned out so as to give a more rational spacing of the trees. The figures in Table 2 show the conditions before and after thinning out. Planting distances of 10 ft. × 10 ft. and 9 ft. × 9 ft. square give 435 and 537 stands per acre respectively. At the same time, all dead wood and unwanted chupon growths were cut out, a pruning routine which has been continued each year.

TABLE 2. AJIA PLOTS: EFFECTS OF THINNING OUT

Plot.	Treatment.	Trees per acre. *Nominal.*	Approximate area in sq. ft. for each tree.
I.	Thinned . . .	477	85
	Unthinned . .	648	67
II.	Thinned . . .	457	92
	Unthinned . .	480	85
III.	Thinned . . .	536	81
	Unthinned . .	741	61
IV.	Thinned . . .	485	86
	Unthinned . .	554	76

Spraying and dusting have been carried out in March at the commencement of the rains, in June when the rains are at their height, and in August if the short dry season occurs. The Bordeaux mixture spray required a ready supply of water, took time to prepare, was comparatively economic in application and was fairly effective. The copper and sulphur dusts were proprietary products which proved easy to handle, uneconomic in application because of their lack of adhesiveness and not very effective.

In Plot IV an attempt has been made to control Black Pod by the regular removal of all dead pods, diseased branches and other sources of infection.

The treated and untreated portions of all plots have been harvested regularly throughout the cropping periods.

The results of the various treatments are summarised in Table 3, where the total yields of healthy cocoa only and of healthy and diseased cocoa for the period 1931–35 have been calculated as pounds of dry cocoa per acre.

The negative results from Plot II are due to the fact that some 10 per cent. of the treated trees have died out during the past two years as a result of waterlogging, where one part of the plot adjoins a marshy stream.

TABLE 3. AJIA PLOTS: YIELDS FOR THE PERIOD 1931–35 CALCULATED AS LB. DRY COCOA PER ACRE

Plot.	Treatment.	Healthy Cocoa.	Healthy and Diseased Cocoa.
I.	Thinned out and pruned—		
	Bordeaux mixture spray	3,260	3,450
	Control—untreated	2,266	2,482
	Difference	+ 994	+ 968
II.	Thinned out and pruned—		
	Copper dust	2,797	2,928
	Control—untreated	2,830	3,068
	Difference	− 33	− 140
III.	Thinned out and pruned—		
	Sulphur dust	4,651	4,903
	Control—untreated	3,818	4,283
	Difference	+ 833	+ 620
IV.	Thinned out and pruned—		
	All dead pods removed	3,130	3,269
	Control—untreated	2,806	2,943
	Difference	+ 324	+ 326

With the exception of Plot II, the figures show yield increases as the result of the various treatments. A striking point is that there is very little difference between the yields of healthy cacao only and of healthy and diseased cacao. This suggests that most of the yield increments

are due to thinning out and pruning ; spraying and dusting have had but little effect.

The costs of spraying and dusting are given in Table 4. They have proved extremely high, and it is obvious that, unless far more efficient and cheaper methods can be found, spraying and dusting cannot be considered by Nigerian farmers. This is in accord with the results obtained by Dade in the Gold Coast ("Economic Significance of Cacao Pod Diseases," *Gold Coast Agricultural Dept., Bulletin No.* 6, 1927.)

TABLE 4.—AJIA PLOTS: TOTAL COSTS FOR THE PERIOD 1931–35

	£	s.	d.
Bordeaux mixture spraying:			
129 lb. of lime at 6*s.* 3*d.* per cwt.	0	7	0
129 lb. of copper sulphate at 26*s.* per cwt.	1	10	0
66 man-days at 6*d.* a man-day	1	13	0
Total	£3	10	0
Copper dusting:			
838 lb. of copper dust at 22*s.* per cwt.	8	5	0
107 man-days at 6*d.* a man-day	2	13	6
Total	£10	18	6
Sulphur dusting:			
1,311 lb. of sulphur dust at 19*s.* per cwt.	11	2	0
107 man-days at 6*d.* a man-day	2	13	6
Total	£13	15	6
Machinery:			
2 bucket sprayers	10	10	0
2 dusters	8	4	6
Total	£18	14	6

Whilst spraying and dusting have so far proved ineffective, these experiments suggest that Black Pod can be brought within economic limits by better agricultural methods. Referring to Table 3, it will be seen that thinning out the trees has produced an increase in yields. This result has been obtained with trees which were from ten to twenty years old.

An even more important point which has been brought out is that regular harvesting throughout the cropping periods is extremely effective. In Table 5 are given the average percentages of diseased pods and diseased beans for the control plots over the period 1931–35. These plots receive no treatment other than that they are harvested regularly.

TABLE 5.—AJIA PLOTS: PERCENTAGES OF DISEASED PODS AND DISEASED BEANS FOR THE PERIOD 1931–35

Plot.	Diseased pods.	Diseased beans.
I. Untreated	19·5	8·7
II. Untreated	16·6	7·7
III. Untreated	25·9	10·8
IV. Untreated	10·0	4·7

It will be seen that the proportion of pods diseased is much higher than that of beans diseased. Were the periods between harvests to be lengthened, the proportion of beans diseased would rise rapidly. This point is further brought out in Table 6. The 1934–35 main crop was badly diseased owing to an exceptionally heavy rainfall.

TABLE 6.—AJIA PLOTS: CONTROL PLOTS; PERCENTAGES OF DISEASED PODS AND DISEASED BEANS FOR THE 1934–35 MAIN CROP

Plot.	Diseased pods.	Diseased beans.
I. Untreated	51·5	19·2
II. Untreated	29·8	12·1
III. Untreated	59·1	36·0
IV. Untreated	24·8	9·1

Harvesting was carried out once a month and, as shown, reduced the potential crop loss, as expressed by the proportion of diseased pods, in a very marked degree. Had the crop been harvested at fortnightly intervals during the peak of delivery, the actual losses would probably have been smaller still.

These experiments are being continued in a modified form. Spraying and dusting have been discontinued, and an attempt is now being made to see how far the results already obtained can be substantiated without the use of fungicides. That regular harvesting is extremely important is obvious. The economic relationship between frequency of harvesting, labour costs and the value of the final crop produced remains to be investigated.

As previously reported (see this BULLETIN, 1935, **33**, 65), on the Ibadan Native Administration Cocoa Farm, which is now being established, two one-acre plots have been set aside for mycological experiments. In the course of time these two plots should yield far more accurate data than can be obtained from the present native farms now in use.

Cocoa Moth Experiments.—Mr. F. S. Golding, Senior Entomologist, reports that specimens of moths collected from stores and bred from larvæ in cocoa beans all proved to be *Ephestia cautella* Wlk.; *E. elutella* has not yet been found (cf. Mr. J. M. Nicol's paper in this BULLETIN, 1935, **33**, 173).

Bionomical experiments with *E. cautella* between February and June showed the duration of the incubation period to be three to four days, the shortest larval period thirty-eight days and the shortest pupal period seven days. The progeny of moths emerging between April 13 and 26 became adult between June 8 and 21.

The Tobacco Beetle, *Lasioderma serricorne* F., was common in cocoa beans which had been stored for some time, but not a single specimen of *Aræcerus fasciculatus* de Geer. was seen.

Coffee

Nigeria.—The following account, by Mr. O. J. Voelcker, of work carried out on coffee, is contained in the report of the Botanical Section, Southern Provinces, for January to June 1935.

Mention was made in an earlier report of the varieties of coffee planted at Moor Plantation (this BULLETIN, 1932, **30**, 325). These varieties were :

C. liberica	Obtained locally.
C. robusta	,, from the Gold Coast.
C. robusta	,, ,, Java.
C. robusta var. Quillou	,, ,, ,,
C. robusta var. Uganda	,, ,, ,,
C. stenophylla	,, ,, Benin.
C. arabica	,, locally.
C. bengalensis (?)	,, ,,

With the exception of the Quillou coffee, each variety is grown in a half-acre plot at a spacing of 12 ft. × 12 ft. for the Robusta and Liberica types, 10 ft. × 10 ft. for Stenophylla and 8 ft. × 8 ft. for Arabica. The *Gliricidia*, planted as shade trees, is well established, but the *Albizzia falcata* is not yet old enough to give satisfactory shade. Fruiting commenced in 1934, but the yields were small, and a large proportion of berries were damaged by insects. Samples of Robusta (Java), Quillou, Liberica and Arabica were sent to a coffee broker in London who quoted possible values for these types ; Arabica at 32*s*. per cwt. was the most promising.

From general appearance in the field, the Java Robusta, Quillou and Arabica bushes seem suited to Moor Plantation conditions, though normally the Liberica types suffer less during the dry season. Indeed, the dry season, with periods of intense harmattan, causes defoliation on all but the Liberica types, and even these lost their leaves during the 1934–35 dry season. Flowering takes place after the first heavy rain, but it appears that little if any crop results from this, probably on account of the weakened condition of the bushes. Somewhat remarkably, the Arabica plants were, at the time of writing, carrying a bigger crop than the other varieties and showed vigorous growth.

The introduced Robusta types have also been established on the Departmental farms at Benin and Umuahia. The results at Benin are disappointing ; growth has been very slow and the bushes have an unhealthy appearance. At Umuahia, the Uganda variety is less hardy than the

Quillou or Robusta, which show reasonable promise. At Agege and Nkwele, Java Robusta alone has been planted, and initial yields are expected this year.

Little can be said at present on the prospects of coffee-growing in Nigeria. Several years must elapse before a reliable indication of yield per acre can be obtained. The indigenous Liberica types are known to yield well, but the berries are troublesome to prepare, and the market for them is restricted. There are indications, too, that pests and diseases may limit the area which can be successfully established with this crop.

Cereals

Guinea Corn

Nigeria.—In his report for the period January to June 1935, Mr. C. B. Taylor, Agricultural Botanist, Northern Provinces, gives the results of two small yield trials with guinea corn carried out in 1934. The layout consisted of randomised blocks with seven repetitions; the area of a single plot was $\frac{1}{72}$ acre. As a control, a mixture of seed obtained from local farmers was used.

Trial No. 1

Strain.	Yield of grain in lb. per acre.	Expressed as percentage of control.	Significant difference as percentage of control.
FS 20	1,199	97·6	22·6 at P = 0·05 30·1 at P = 0·01
FS 26	1,310	111·7	
AF 51	1,826	148·6	
F 50	1,397	113·7	
AF 5	1,435	116·8	
AF 21	1,439	117·1	
AF 41	1,241	101·1	
FS 30	1,400	113·9	
FS 5	1,369	111·4	
Control	1,229	100·0	

Strain AF 51 is a descendant of the old FB strain, which in the last report was stated to have become mixed and had been discarded (this Bulletin, 1935, **33**, 67).

Trial No. 2

Strain.	Yield of grain in lb. per acre.	Expressed as percentage of control.	Significant difference as percentage of control.
AF 1	1,835	121	13 at P = 0·05
AF 7	1,604	106	
AF 54	1,629	108	
FS 4	1,654	109	
FS 5	1,608	106	
FS 28	1,447	96	
FS 34	1,561	103	
F 7	1,646	109	
T 1	1,769	117	
Control	1,510	100	

Strains AF 1 and T 1 are recent selections.

ROOT CROPS

Cassava

Gold Coast.—The report furnished by the Director of Agriculture for the period July to December 1934 contains the following account of work carried out on cassava.

Cassava Mosaic.—The Economic Botanist has continued the work of endeavouring to breed resistant types along the lines set out in the previous report (this BULLETIN, 1934, **32**, 447). Seedlings when established are tested for resistance to mosaic by being budded with infected material. This is a drastic test, but it has the advantage of showing quickly whether the seedling is readily susceptible to infection. It is, of course, an artificial test and cannot take the place of field trials, but it serves to afford useful preliminary information in showing if a seedling is worthy of inclusion in field trials. The technique of cross-pollination has been improved as a result of experience, and a higher percentage of seeds is being obtained. Germination of seeds was another problem, but this difficulty has been largely overcome by the use of a locally-made solar propagator, which has improved the percentage tremendously and in addition has reduced the average time of nearly two months to about sixteen days.

HCN Content of Cassava.—In collaboration with the Botanist, the Chemist has carried out preliminary tests for palatability, and among the more important results it has been found that: (i) mosaic infection does not appear to alter the HCN content; (ii) the HCN content in most cases differs considerably in the same varieties grown at different centres; (iii) in some varieties just mature tubers show a higher HCN content than fully mature tubers, whilst in other cases the reverse happens; (iv) considerable variation in HCN content may occur in the same variety at the same stage of maturity; (v) the percentage of peel (bark and cortex) varies from approximately 13 to 17 per cent. It is higher in less mature tubers.

Nigeria.—In connection with the work being carried out by the Department of Agriculture on mosaic disease of cassava (see this BULLETIN, 1935, **33**, 68) it is of interest to note that, according to Mr. F. S. Golding, Senior Entomologist, in his report for January to June 1935, evidence has been obtained that this virus disease is carried by the white fly, *Bemisia nigeriensis* Corbett.

Yams

Nigeria.—Mr. J. West, Botanical Section, Southern Provinces, in his report for January to June 1935, makes

further reference to the comprehensive collection of Nigerian yam varieties which is being studied at Ibadan (see this BULLETIN, 1935, **33**, 69). During the 1934–35 season, a number of varieties produced male and female inflorescences. Small quantities of seed were obtained from several varieties and some fifty seedlings were successfully germinated in the nursery. Growth has been slow, and it would appear that at least two years must elapse before tubers of any size will be produced. Attempts will be made during the present season to produce artificially pollinated seed.

FRUITS

Citrus

Nigeria.—The following statements relating to work on citrus fruits are contained in the report of the Botanical Section, Southern Provinces, for the period January to June 1935.

Mr. E. H. G. Smith deals further with the extensive introductions of the best strains of the common citrus varieties which have been made in recent years (see this BULLETIN, 1935, **33**, 70). The object in view with this crop is twofold: firstly, to improve the quality of fruit available for local consumption; secondly, to test the possibility of a future fruit export trade. In order to test the various introductions, and to provide for future propagation, planting is in progress at all experimental stations. Material as introduced has been established at Ibadan, the principal agricultural station in the south, and local reproductions are used for planting elsewhere. Departmental planting is proceeding on a comparatively large scale at Ibadan and at Agege, the latter a possible future fruit centre, and to a lesser extent at other stations.

At Ibadan the initial programme comprises some 400 trees, of which three-quarters have been established during the past three years. In addition, Ibadan has a further area devoted to stock seed trees, and to a reference collection of miscellaneous citrus. At Agege, rather more than half the trees are already planted. Benin, Onitsha and Umuahia are to have from 150 to 200 trees, and Owena sixty. Planting at these stations is rather less advanced. Stock tests are being undertaken at all stations, but pending the results of these, sour orange has been adopted as the standard stock. The planting programme should be completed in 1936.

There is a growing demand by native farmers in the Western Provinces for budded citrus trees which will yield fruit suitable for export. This year, sufficient supplies of

grapefruit trees are available to satisfy only a very few of these applicants and every endeavour is being made to increase the supplies for future years.

Mr. J. West reports that, as previously mentioned (this BULLETIN, 1935, **33**, 70), Scab disease (*Sporotrichum citri*) broke out severely in 1934 on sour orange seedlings at Ibadan. In early November 1934, a number of beds of sour orange seedlings were shaded at a height of 18 in. with palm shade, in accordance with the control methods advocated by Briton-Jones in Trinidad ("The Control of Scab in the West Indies," *Tropical Agriculture*, 1933, **10**, 40). Unshaded and sprayed beds were adequately interspersed through those shaded so as to afford a check on the experiment. At the end of March 1935 the shade was raised to a height of about 5 ft. An examination of the beds at the time the shade was raised gave the following results:

1. No shade—sprayed with Bordeaux mixture.
   4 beds. 277 seedlings. 35·0 per cent. infected.
2. No shade.
   13 beds. 929 seedlings. 34·3 per cent. infected.
3. Shaded.
   36 beds. 3,049 seedlings. 3·5 per cent. infected.

A further six beds of sour orange seedlings, not included in the above figures, were left with the shade at 18 in. for too long a period. The seedlings grew through the shade and the majority of such unshaded shoots became infected, whereas the foliage under the shade remained healthy.

Whilst the period covered included a severe dry season, the infection percentages in the sprayed and unshaded beds show that the effect of shade had been most effective. The end of March was extremely wet, but an additional count made in the middle of May showed that the disease had not then become any more prevalent in the shaded beds. It remains to be seen how effective shade alone as a control measure will prove during the height of the rains.

Mr. F. S. Golding, Senior Entomologist, states that adults and nymphs of a Capsid bug attacking young shoots of citrus in November and December 1934 proved to be *Sahlbergella theobroma* Dist. This is the first time since 1914 that this species has been recorded in Nigeria. Efforts are being made to elucidate its life history and to determine whether the species attacks young cacao trees in Nigeria as it does in the Gold Coast.

Sierra Leone.—A report by Mr. C. Hargreaves, Entomologist, Department of Agriculture, published in this BULLETIN (1933, **31**, 85), dealt with the problem of fruit-piercing Lepidoptera, which are a serious pest of citrus fruits in Sierra Leone. Subsequent reports (1934, **32**, 146, 452) added to the list of host-plants in which the larvæ occur. In a report for the first half-year 1935, Mr. Hargreaves gives the following list of new hosts for some of the species of fruit-piercing moths.

Achæa catocaloides Guen.—*Alchornia hirtella, Byrsocarpus coccineus, Cnestis ferruginea, Cola nitida, Combretum comosum, Connarus africanus, Costus afer, Dichapetalum toxicarium, Dioscorea hirtiflora, Leptoderris* cf. *L. brachyptera, Macaranga huræfolia, Millettia barteri, Napoleona heudelotii, Ochthocosmus africanus, Sorindeia juglandifolia, Uvaria chamæ.*

Achæa ezea Cram.—*Combretum comosum, Combretum mucronatum.*

Achæa faber Holl.—*Combretum comosum.*

Achæa lienardi Boisd.—*Combretum comosum, Combretum mucronatum, Napoleona heudelotii, Ochthocosmus africanus, Phyllanthus discoideus.*

Anua mejanesi Guen.—*Combretum comosum.*

Parallelia algira L.—*Phyllanthus discoideus.*

Serrodes ? trispila Mab.—*Deinbollia pinnata.*

Serrodes ? partita F.—*Lecaniodiscus cupanioides.*

OIL SEEDS

Ground-nuts

Nigeria.—The report of Mr. K. T. Hartley, Agricultural Chemist, Northern Provinces, for January to June 1935, states that the work on the oil content of ground-nuts, referred to in this BULLETIN (1934, **32**, 454) has been continued. It was shown in the previous report that the samples of ground-nuts collected from trading firms at Gusau and Sokoto contained more oil than the Botanist's selected strain grown on the Department's own farms in the same neighbourhood. This was followed up by collecting seed direct from native farmers in those districts and growing this seed side by side with the selected strain—known as " Castle Cary "—on the Department's farms at Gusau and Sokoto. Samples of the local nuts were also sent to Kano and Samaru and were grown there along with " Castle Cary." The oil contents of all the crops were determined with the following results :

COMPOSITION OF CASTLE CARY, GUSAU AND SOKOTO NUTS GROWN AT DIFFERENT PLACES

	Sokoto. *Per cent.*	Kano. *Per cent.*	Gusau. *Per cent.*	Samaru. *Per cent.*	Average. *Per cent.*
Oil content in dry matter:					
"Castle Cary"	48·0	51·9	51·8	49·5	50·3
"Sokoto"	47·8	51·8	—	47·8	49·5
"Gusau"	—	51·4	50·4	47·2	49·7
Average	47·9	51·7	50·9	48·2	—
Crude protein in dry matter:					
"Castle Cary"	32·4	26·2	27·7	26·4	28·2
"Sokoto"	30·6	28·5	—	28·2	29·1
"Gusau"	—	28·0	29·0	27·6	28·2
Average	31·3	27·6	28·4	27·4	—
	grams.	*grams.*	*grams.*	*grams.*	*grams.*
Weight of 100 kernels:					
"Castle Cary"	46·3	51·1	44·3	41·9	45·9
"Sokoto"	31·9	32·0	—	31·6	31·8
"Gusau"	—	45·4	41·2	38·8	41·3
Average	39·1	42·8	42·7	38·1	—

It will be seen that the variation in oil content between places is much greater than between varieties grown at the same place. The same is true of protein content, which varies inversely as the oil content. Size of kernel, however, seems to be more strictly characteristic of variety.

This season's results show that the selected strain is superior in oil content to any other local variety grown in the same environment. The work is being repeated in the coming year for confirmation of these results.

Oil Palm

Nigeria.—Mr. E. H. G. Smith, Botanical Section, Southern Provinces, in his report for January to June 1935, states that varietal classification on fruit characters of the oil palm has been continued as the palms of the first generation of the Calabar selections came into bearing. While little useful information on inheritance can be added to the figures given in the report for July 1934 (this BULLETIN, 1934, **32**, 454), it may be of interest to record a few notes on the tentative classification at present followed.

Palms are classified on the fruit appearance alone; and are divided into types on external characters, and into forms on internal characters. The external classification appears to be straightforward. Four types are recognised, and are as follows:

(i) Ordinary type (non-green-fruited and non-mantled).
(ii) Mantled type (mantled but non-green-fruited).
(iii) Green-fruited type (green-fruited but non-mantled).
(iv) Mantled green-fruited type (both mantled and green-fruited).

The internal classification is based on mesocarp thickness, shell thickness and kernel size, each of the above types being sub-divided into two forms, the one thick-shell, the other thin-shell. The terms " thick-shell " and " thin-shell" are arbitrary and are used to describe two well-recognised internal forms of oil-palm fruit. The typical thick-shell fruit has a thin mesocarp, a thick shell and a large kernel; and the typical thin-shell fruit, a thick mesocarp, a thin shell and a small kernel. But considerable variation of internal form occurs in oil-palm fruit; the internal components appear to be controlled by a number of genes, and to vary independently of each other. To quote but two examples: fairly thick mesocarp is bound with thick shell and large kernel, and thick mesocarp with a thinnish shell but a largish kernel. Again definite intermediates appear, and there are extreme examples at both ends of the scale; palms with a very thick shell, and palms with a minute kernel but no shell (shell-less), or palms with neither shell nor kernel (kernel-less). Size of fruit appears also to be of importance, and there seems to be a real difference between the thin-shell palm known in Africa as the " Lisombe," and the common or " Osok " thin-shell palm. The present dividing line between the thick- and thin-shell forms is that the fruit of the latter contains the mesocarp fibre ring, and that the nuts can be readily cracked (Smith, E. H. G., " Oil Palm at Calabar," *8th Annual Bulletin, Agricultural Dept., Nigeria*, 1929). Thus the thin-shell form contains the following variations: (i) Kernel-less, (ii) Shell-less, (iii) Thin-shell, (iv) Intermediate thin-shell; and the thick-shell form: (i) Intermediate thick-shell, (ii) Thick-shell, (iii) Very thick-shell.

Such a grouping can only be regarded as a tentative one, but further expansion is undesirable pending the examination of many more variations of fruit form than are as yet available in the oil-palm selection blocks.

Fibres

Cotton

Nigeria.—The report of the Botanical Section, Southern Provinces, for January to June 1935, contains the following statement by Mr. E. H. G. Smith on cotton selection in the Western Provinces of Southern Nigeria. Originally, a variety of *Gossypium peruvianum*, locally known as " native " cotton, was exploited exclusively in this area, and this variety still persists in certain more remote districts where there is a local weaving industry. After extensive trials of this cotton, of Allen (*G. hirsutum*), and

of Ishan (according to Dr. Harland a variety of *G. barbadense*), improved Ishan strain A was first distributed to the farmers in 1927, and is now, with the above-mentioned exception, exclusively grown. Ishan A was the most satisfactory of a number of strains bred up by Mr. C. J. Lewin, the original material being obtained from the Ishan Division of Benin Province. Thus while Ishan cotton has long been grown in Southern Nigeria, it was not the native cotton of the Abeokuta and Oyo Provinces, which form the most important cotton-producing area.

As has been mentioned in previous reports, improved Ishan strain A is in most respects an eminently satisfactory cotton, the principal defect being the extreme roughness of the lint. As has also been previously reported, an attempt is being made, on Dr. Harland's advice and with his co-operation, to graft the smooth lint character of Sea Island on to Ishan A. These cottons have been crossed, and the F_1 has been backcrossed on to Ishan A for two generations. At present this work has not yet reached the stage of the multiplication of new strains for field trials.

During the season 1934–35, both first (Ishan A × Sea Island) × Ishan A, and second [(A × SI) × A] × A, generation backcrosses were under trial at Moor Plantation. Some strains had been produced in St. Vincent, others were the result of local crossing.

The past cotton season was most disappointing, and was an abnormal one in that the usual break in the rains during the growing period did not occur. Cotton at Ibadan is sown about July 1, some three months after the first rains begin. There is usually a break in the rains, known as the short dry season, which extends for about six weeks, and which may occur at any time between the last week of July and the end of August; June, July and September being months of heavy rainfall. The break in the rains occasions a check in the development of the cotton plants. Serious flowering begins during October, the last month of appreciable rain, and the flowering peak is reached normally about the middle of November. It is usual for cotton to shed buds and bolls heavily until heavy rain ceases. In 1934, as a result of the absence of a check in growth during August, the cotton was very forward by the end of September, and the flowering peak was reached towards the end of October, two to three weeks before the usual time. The wet conditions also favoured the incidence of bacterial disease, which appears to be largely controlled at Ibadan by climatic factors. As a result of the heavy rainfall, and of the prevalence of bacterial disease, loss of potential crop was severe. The

loss of crop extended into November, right past the peak of flower production. The plants were of reasonable size, and should have carried a fair crop, but this had been largely lost from the fruiting branches. Consequently, yields were low and irregular.

These low and irregular yields were a handicap to selection within the comparatively large number of Ishan A × Sea Island first backcross progenies under trial. Selection was very largely based on vegetative and lint characters. Towards the end of the growing season a rigorous field selection on the vegetative character was made, particular attention being paid to hairiness. As bolls opened, plants that had passed the first test were further selected for smoothness of lint. A final selection followed in the laboratory, when halo lengths and ginning percentages were determined, and twenty-six selections were made for next season. The rough lint character of Ishan A was found to be very persistent, even in these first backcrosses, and many progenies were no better than, or showed but little improvement on, the Ishan parent.

A number of second generation backcrosses were grown, and these appeared to be far from promising on account of a very general tendency to an Ishan A type of lint. A few selections were made, but this material appears less likely to give the desired result.

To summarise the season's results, there seems to be a wealth of likely cottons, but the apparent persistence of the rough lint character of Ishan A is a somewhat discouraging feature.

Uganda.—The half-yearly report on investigations carried out at the Serere Plantation for January to June 1935 contains the following summary by the Assistant Botanist of the main experiments.

Miniature Variety Trial.—This experiment consisted of 136 one-row plots of seventeen varieties, replicated eight times in random blocks. Each sub-plot consisted of one row of fifty plants each. The object of the experiment was to test a number of promising strains of which insufficient seed was available for inclusion in larger trials.

Variety.	Yield. *lb.*	Variety.	Yield. *lb.*
N.17	8·55	S.P.20	10·49
S.G.29	5·14	S.P.39	10·34
S.48	8·61	S.P.40	11·16
S.P.36	5·28	S.P.43	11·54
S.P.71	5·59	S.P.48	12·51
S.P.72	5·90	S.P.25	8·50
U.4.4.K	13·18	S.P.56	9·47
S.P.1	8·92	S.P.57	14·22
S.P.13	9·24		

The outstanding results were :

(*a*) N.17 gave a significantly higher yield and developed fewer black-arm lesions per plant than S.G.29.

(*b*) All the selections showed considerably lower black-arm infection than the two standard varieties N.17 and S.G.29.

(*c*) The high yields of S.P.48 and S.P.57. The latter is particularly encouraging, as it is a re-selection from S.P.25 and has superior lint to the other U.4.4 strains included in this trial.

Sowing Date and Spacing Trial with variety S.G.29.—This experiment took the form of a duplicated 3 × 3 Latin Square for sowing dates. Each sowing date " cell " was divided at random into the three spacings. A similar experiment was conducted in the previous season so that two seasons' results could be combined in one analysis of variance.

The results for the 1934–35 season were as follows :

Sowing dates irrespective of spacing	Yield per acre. *lb.*	Significant difference.
May 16	387	57
June 17	418	
July 15	431	

No significant difference between sowing dates.

Spacings irrespective of sowing dates.	Yield per acre. *lb.*	Significant difference.
3 ft. × ¼ ft..	396	26
3 ft. × ½ ft..	421	
3 ft. × 1 ft..	420	

No significant difference between spacings.

The interaction of sowing date × spacing was highly significant, because :

(*a*) In May there was no difference between spacings.

(*b*) In June 3 ft. × 1 ft. gave a better yield than the two closer spacings.

(*c*) In July the two closer spacings gave a better yield than 3 ft. × 1 ft.

Combining the results of the two seasons 1933–34 and 1934–35 the following results were obtained :

Sowing dates irrespective of spacing.	Yield per acre. *lb.*	Significant difference.
May	314	32
June	300	
July	288	

No significant difference between sowing dates.

Spacings irrespective of sowing dates.	Yield per acre. *lb.*	Significant difference.
3 ft. × ¼ ft.	286	20
3 ft. × ½ ft.	306	
3 ft. × 1 ft.	309	

3 ft. × 1 ft. and 3 ft. × ½ ft. were significantly better than 3 ft. × ¼ ft.

The interaction of seasons × sowing dates was highly significant because in the 1933–34 season, May gave a better yield than June, which gave a better yield than July. In the 1934–35 season the order was exactly reversed.

The interaction of seasons × spacings was not significant.

The interaction of spacings × sowing dates was significant because 3 ft. × 1 ft. gave the best yield for May and June sowing dates, whereas 3 ft. × ½ ft. gave the best for July.

Combined Variety, Dusting and Sowing Date Trial.—The lay-out was as follows:

Standard Plots (27 ft.×27 ft.) and spacing 3 ft.×1 ft.

4 × 4 Latin Square for four sowing dates. Each sowing date "cell" of the Latin Square was divided into three strips of plots at random for the seed treatments Control, Dust 413*a* and Dust Abavit B.

There were forty-eight replications of each variety irrespective of sowing date or seed treatment, and ninety-six replications of each seed treatment irrespective of variety or sowing date.

The different treatments were as follows:

Sowing dates:	April 24.
	May 15.
	June 12.
	July 16.
Seed treatment:	Control.
	Dust 413*a*.
	Dust Abavit B.
Varieties:	S.G.29. Control.
	S.P.1.
	S.P.20.
	S.P.21.
	S.P.48.
	S.P.72.

A complete statistical analysis will be given in the *Annual Report* of the Department for 1934. The Assistant Botanist's summary is given below:

Varieties (irrespective of sowing dates or seed treatments).

Total cotton.

S.P.48. Significantly higher yielder than all others.

S.P.21. Equal to S.P.20; both significantly higher yielders than S.P.1, S.P.72 and S.G.29.

S.P.1. Significantly higher yield than S.P.72 and S.G.29.

S.P.72. Equal to S.G.29.

Clean cotton.

Results same as for total cotton.

Sowing Dates (irrespective of seed treatments or varieties).

Total cotton.

June equal to July.
June better than May and April.
July, May and April all equal.

Clean cotton.

June equal to July.
June better than May and April.
July better than April but equal to May.

Seed Treatments (irrespective of sowing dates and varieties).

Dusts had no effect on general yield.

Interaction of Sowing Date × Seed Treatment.

Seed treatments showed no differences in April, May and July. But in June, both dusts resulted in a significant increase of yield over control.

Interaction of Variety × Sowing Date.

The nature of this interaction is rather obscure: to simplify matters the following table is given. In this, each varietal monthly mean is expressed as a percentage of the mean yield of all varieties for the appropriate month.

	April.	May.	June.	July.
S.G.29	68·7	70·4	65·9	71·2
S.P.1	100·6	106·1	104·6	105·4
S.P.20	118·5	110·6	111·2	113·6
S.P.21	120·8	109·4	112·2	117·1
S.P.48	115·3	129·3	132·6	131·5
S.P.72	76·1	74·3	73·5	61·1

From this it will be seen that the varieties responded in different ways to the four sowing dates, viz.:

S.G.29 gave the best relative yields in May and July.

S.P.1 gave a low relative yield in April.

S.P.20 and S.P.21 (very closely related) gave relatively high yields in April and July.

S.P.48 gave its highest relative yields in June and July.

S.P.72 gave lower relative yields as the sowing date became later.

The most outstanding results are: the obvious preference of S.P.48 for late planting, and its enormous increase over S.G.29; the increase of yield of successive generations S.P.1, S.P.20, S.P.21, and S.P.48 (all U.4.4.2 derivatives); the failure of dusts to alter general yield except during June, despite the significant reduction of black-arm infection; the shift of the optimum sowing date from May to June–July, as in the previous bad black-arm year 1929–30; the extraordinary accuracy of this complex experiment, the standard error of a single plot being 1 per cent. of the general mean and differences of only 7·1 per cent. of the general mean demonstrate significant differences between variety totals.

Owing to the success of this experiment a similar complex experiment of 288 sub-plots is to be laid down in the 1935–36 season, substituting three spacings for the three seed treatments.

The following experiments are also reported on.

Manurial Experiment.—The results of the cotton crop (variety U.4.4) grown in 1934 were as follows:

Treatment.	Yield per acre. *lb.*
Control	413
Lime	394
10 tons farmyard manure per acre	535
20 ,, ,, ,, ,, ,,	526
30 ,, ,, ,, ,, ,,	549

Following the cotton, the plots were planted to ground-nuts (Local Bunch type) on April 23 and 24, 1935.

Rotation Experiment.—The second rotation for 1934 gave very poor results, the yields for the various series and crops being as follows:

Crop.	Rotation Series.	Yield. *lb.*	Yield per acre. *lb.*
Cotton	A.2	5·25	42
	B.2	9	72
	C.2	7	56
	D.2	6	48
	A.3	9	72
	B.3	14·6	117
	C.3	6·7	54
	D.3	9·3	74
Green manure	B.1	Dug in.	
Sim-sim	A.1	Total failure owing to dry weather.	
Ground-nuts	C.1	,, ,, ,, ,, ,, ,,	
Millet	D.1	,, ,, ,, ,, ,, ,,	

The plots have been planted to the next rotation crops as shown below :

Series.	Crop.	Planted.
A.1 ; C.2 ; D.1 .	Green manure	13.4.35
A.3 ; B.2 ; D.3 .	Ground-nuts	13.4.35
A.2 ; C.1 ; B.3 .	Millet	14.2.35 Resown 12.3.35 and 5.4.35
B.1 ; D.2 ; C.3 .	Sim-sim	13.3.35 ,, 5.4.35

TOBACCO

Gold Coast.—According to the report of the Director of Agriculture on investigations conducted during the period July to December 1934, farmers showed some interest in tobacco, more especially in the Eastern Province, and the Department obtained seeds of various types for trial and gave advice as to cultivation and curing. Satisfactory crops were obtained, but the locally-produced leaf has not sold well because it lacks the " bite " of imported leaf. Various methods of treatment during and after curing are being tested with the object of suiting the local taste for a full-flavoured leaf.

DRUGS

Kola

Nigeria.—Further reference to the subject of colour in kola nuts is contained in a report by Mr. O. J. Voelcker, Botanical Section, Southern Provinces, for the period January to June 1935. In the previous report (this BULLETIN, 1934, **32**, 462) it was shown that trees planted from white nuts under normal conditions of pollination yielded both white and coloured nuts, but when the flowers were self-pollinated white nuts alone were produced.

Apart from the small plot of kola, *Cola nitida* A. Chev., grown from white seed at Moor Plantation, Ibadan, there exist a plot grown from pink seed and another from red seed. Pollen from the red seed was used to fertilise flowers on the white-seed plot, and reciprocal crosses were made. The classification of colour in the resulting nuts was difficult owing to the numerous variations in colour intensity ; white alone could be classed as a distinct group. Two other groups, pink and red, were made, but variations occurred within each of these, and it was sometimes difficult to decide into which group a nut should be placed. The results obtained are summarised below :

	White.	Pink.	Red.
Trees planted with white nuts produced when :			
Naturally pollinated (1931–34)	1,113	84	180
Self-pollinated (1933–34)	745	—	—
Crossed with pollen from trees grown from red nuts (1934)	11	94	721
Trees planted with red nuts produced when :			
Crossed with pollen from trees grown from white nuts (1934)	—	60	149

Under natural pollination conditions the red trees give almost all red nuts ; exact figures, however, have not been kept.

An examination of colour in nuts from individual crosses showed that pollen from certain " red trees " when used on " white flowers " yielded only red nuts, while pollen from other " red trees " produced either a mixture of pink and red, or white, pink and red. Similarly, when " white tree " pollen was used to fertilise flowers on " red trees," some of these " red trees " gave only red nuts, while others gave pink and red. A tentative suggestion put forward is that colour is a complex factor determined by a number of genes. Whiteness would be a pure recessive, and, as such, breed true when self-fertilised. Redness might indicate complete colour dominance, but could still occur when some of the colour genes were absent. On growing such nuts as these latter, the flowers, if fertilised with " white " pollen, would produce a mixture of pink and red, or white, pink and red. Further work remains to be done in elucidating these colour factors.

A fuller account of Mr. Voelcker's work on cotyledon colour in Kola is given in a paper contributed by him to *Tropical Agriculture*, Vol. XII, No. 9, September 1935, pp. 231–234.

An indication of the distance over which kola pollen is carried has been given. If the theory is correct that coloured nuts occurring on trees grown from white seed are the result of out-pollination, then such coloured nuts as were found under natural conditions in the white-tree plot must have been caused by foreign pollen. The shortest distance between the white-tree plot and coloured kola trees was 300 ft. ; pollen from the coloured trees would have been carried at least this distance. The agencies of pollination are not known, but a somewhat sticky pollen suggests insects.

As the cotyledons are modified leaves, it was suggested that colour pigment or absence of colour pigment—so obvious in the cotyledons—could also be noted in leaves at a later stage of growth. Sections of leaves from white-tree and red-tree kola were examined microscopically, but no red pigment could be found in either. The only difference noted between trees grown from white nuts and those grown from coloured is the presence of a purple longitudinal streak near the base of the calyx of the latter ; this streak is absent in trees grown from white nuts.

MINERAL RESOURCES

CYPRUS

THE Imperial Institute has received the following statement from the Acting Colonial Secretary in regard to the mining operations carried out in Cyprus during the six months ended June 30, 1935.

The production of cupriferous pyrites for the first six months of 1935 continued to show a satisfactory increase due to the expansion in operations at the Mavrovouni mine. It is expected that the output will be increased still further when the new metallurgical plant is working to full capacity.

Although a smaller tonnage of asbestos rock was mined by the Cyprus & General Asbestos Co., Ltd., compared with the corresponding period in 1934, the Company has maintained its export figures by drawing on stocks. The scale of operations by this Company is entirely governed by the market requirements for its product.

Towards the close of the period under review more applications were received for prospecting permits, and a considerable increase in prospecting operations is expected in the immediate future.

Assuming that there is no further set-back in the price of metals, the general outlook may be described as one promising slow but steady improvement.

WORK DONE BY THE CYPRUS MINES CORPORATION AT THE SKOURIOTISSA PYRITES MINE

	First 6 months 1935.	First 6 months 1934.
Underground development, footage	766	1,276
Tonnage mined	43,133	68,787
Underground labour (average per day)	657	829
Tonnage exported	44,060	61,713
Labour, surface and underground (average per day)	1,303	1,465

WORK DONE AT THE MAVROVOUNI PYRITES MINE BY THE CYPRUS MINES CORPORATION

	First 6 months 1935.	First 6 months 1934.
Underground development, footage	7,582	7,354
Tonnage mined	106,660	33,129
Underground labour (average per day)	761	235
Tonnage exported	63,258	26,450
Labour, surface and underground (average per day)	1,456	1,000

WORK DONE AT THE TROODOS MINES OF THE CYPRUS CHROME CO., LTD.

	First 6 months 1935.	First 6 months 1934.
Development, total footage	201	220
Tonnage of chrome iron ore mined	205	120
Tonnage of chrome iron ore exported	Nil	Nil
Labour (average per day for 3 months)	41	50

WORK DONE BY THE CYPRUS MINES CORPORATION, SKOURIOTISSA, IN THE PRODUCTION OF "DEVIL'S MUD" (AURIFEROUS ANDESITE)

		First 6 months 1935.	First 6 months 1934.
Underground development, footage		17,817	11,465
Tonnage mined		5,710	3,924
Gold ore exported	*tons*	1,594	593
Gold content of gold ore exported	*oz.*	4,632	4,123
Silver content of gold ore exported	*oz.*	27,643	27,033
Gold-bearing metallic precipitate exported	*tons*	3	1
Gold content of the above metallic precipitate	*oz.*	2,240	1,793
Silver content of the above metallic precipitate	*oz.*	16,893	10,894

WORK DONE BY THE CYPRUS AND GENERAL ASBESTOS CO., LTD., AMIANDOS

		First 6 months 1935.	First 6 months 1934.
Rock mined	*tons*	269,080	407,795
Rock treated	*tons*	54,129	85,320
Finished asbestos produced	*tons*	3,771	2,743
Finished asbestos exported	*tons*	3,781	3,334
Average daily labour (quarries only)		439	732
Average daily labour (all operations)		834	1,193

MINERALS EXPORTED OTHER THAN THOSE DEALT WITH ABOVE WERE AS FOLLOWS

		First 6 months 1935.	First 6 months 1934.
Gypsum, calcined	*tons*	3,268	4,736
Gypsum, raw	*tons*	2,848	1,128
Stone, building	*cu. yds.*	2	73
Stone, pumice	*tons*	1,275	322
Terra umbra	*tons*	2,547	2,411
Terra verte	*tons*	18	19

As stated in the article on "The Economic Resources of Cyprus" (p. 319), the Lymni pyrites mine of the Cyprus Sulphur & Copper Co., Ltd., suspended operations in June 1932. A certain number of men have to be kept employed there, however, the average per day for five months during the first half of 1935 being five, as compared with two during the corresponding period of 1934.

GOLD COAST

The Imperial Institute has received from the Director of the Gold Coast Geological Survey the following account of the work carried out during the half-year ended June 30, 1935.

The survey of the gold resources of the Colony and Ashanti was continued and two parties started work in the Northern Territories at the end of March.

At the request of mining companies, advice was given, after geological investigations had been made of several gold mines and prospects. Numerous other mines and prospects were also examined.

The banket conglomerate and associated beds of the Tarkwa-Aboso gold-field were traced and mapped in a north-eastern direction from Damang and Insu to the Anum River in Ashanti. They were tested in very many places, but little or no gold was found.

A line of auriferous reefs, some of which yielded encouraging prospects of gold, was discovered by the Director in the Lawra District, and traced for eight miles. There are no old gold workings and previously gold was not known to exist in the district.

An investigation of the country around Pudo, Lawra District, where deposits of titaniferous magnetite and hæmatite were discovered by the Geological Survey in 1927 and 1929, revealed the presence of other deposits of the same type.

Two small deposits of limestone were found near Du, which is on the south side of the White Volta River on the Walwale-Navrongo bush road.

The gravels of small tributaries of the Bonsa River near Dompim, Wasaw District, are being worked for diamonds by the Africans. Nearly 5,000 carats were produced in 1934 and the output is steadily increasing. The original discovery of diamonds in this locality was made by the Geological Survey in 1922. The bed rocks are Kawere conglomerate and grit, but the head-waters of the streams traverse Upper Birrimian greenstone and schists.

In addition to diamonds, the concentrates contain staurolite, ilmenite, gold, tourmaline, zircon, kyanite and a little sapphire and chrysoberyl.

Memoir No. 4, *Gold in the Gold Coast*, was published in April.

NIGERIA

The Imperial Institute has received from the Director of the Geological Survey the following report on the work carried out during the six months ended June 30, 1935.

Gold

Three new standard sheets of the map, viz. Kaduna, Kakuri and Bichini (from north to south respectively), representing the eastern flank of the area already surveyed geologically, are nearing completion by the Survey Department. The most southerly section (Bichini), which includes the important producing areas of Kazai and Beni, was surveyed geologically during the dry season. Two features of outstanding geological interest are: (*a*) the confirmation of the presence of a shatter belt which joins the two areas of Beni and Kazai, and passes through the centre of

the Nigeria Gold Mining Company's workings at Beni, thus again demonstrating the importance of tectonics ; (*b*) the base of the Nupe Sandstones is being worked for the first time on a reach of the Beni River below Beni. The deposit which is cut through by the river is approximately 30 ft. thick, with about 2 ft. of auriferous rubble at the base. It is not extensive in area so far as is known at present, and is being worked by natural sluicing below a step in the Beni River. Values, however, are generally low.

The monthly output of gold is being maintained at slightly above 3,000 oz., and for the half-year will be about 20,000 oz.

Water Supplies

In the Northern Provinces the programme of shaft sinking for water has progressed steadily with the result that seventy-nine wells have been brought into production for a footage of 9,924 ft. sunk.

Katagum.—The annual incidence of guinea-worm led to a pathological examination of the rivers and wells of Katagum Emirate of Bauchi Province, the result of which showed that in all rivers and pools infected cyclops were in abundance while wells were found to be free. Work was accordingly commenced at Katagum, on the Katagum River, in February and extended to Sakwa, Gamawa and Gadau Districts. The Administration has decided to extend the original programme of work so as to improve the water supply of the whole emirate in places where the life of a native well is short and where water is generally scarce. By the end of June, twelve shafts were producing.

Bornu.—Well-sinking has been continued along the main Balle-Maiduguri road, and the programme in that area is now almost finished. Eight wells have been completed and in all except one, which lies near the Maiduguri River, prolific sub-artesian rises were tapped. Several of these rises measure 60 ft., while one reached 119 ft.

Five tube wells have been driven on the River Alo at Maiduguri at various crossings. These are proving most popular and are being used practically continuously day and night. Five wells have been commenced in and around Maiduguri and it is expected they will be completed before the advent of the rains.

Sokoto.—In Sokoto Emirate work has been carried on in Tangaza District, in the extreme north-westerly corner of Nigeria, with very satisfactory results. Ten wells have been brought into production, averaging 199 ft. in depth, of which five produced sub-artesian rises. The greatest of these measured 117 ft. A further two wells sunk at the

end of 1934 were deepened to sub-artesian water and eight others are sinking.

At the request of the Argungu Native Administration, well-sinking operations were started in Argungu Emirate at the end of January on a small scale. Four wells are sinking, totalling 448 ft., but none have yet been brought into production. Some delay has been experienced owing to encountering gas in two shafts, but artificial ventilation is now installed.

Kaiama.—The principal problem in Ilorin Province was to provide a water supply for the town of Kaiama. The town suffered from a foul rather than an insufficient water supply, guinea-worm and other water-borne diseases being rife. There were a number of shallow wells in the town itself, but the main supply was obtained from a large evil-smelling and rank pool called Kura Imi, to the south.

Seven wells were sunk in the town, the underlying rock being a slightly decomposed gneissose granite. These wells are deeper than the original native wells, giving a total footage sunk of 349 ft. and a standing capacity of 8,000 gals. Each well was lined with reinforced concrete to rock head and a coping 3 ft. high built to prevent the return of spillage and consequent contamination.

The pool, Kura Imi, was cleaned and excavated to below the aquifer, the excavation being 45 ft. square. A reinforced concrete reservoir was constructed, 37 ft. square in plan, with a capacity of 60,000 gals., completely roofed over with reinforced concrete except for a square opening in the centre for inspection and cleaning purposes. On this opening a square section shaft was erected and the shaft sealed with a heavy wooden trap. The water enters the reservoir through flow-ports along the lower periphery of the side walls. The excavation around the reservoir was filled back with clean broken stone to within 2 ft. of the top and then the whole filled to surrounding ground-level with clean sand. The whole reservoir is well below ground-level, and the only portion visible when the work was completed was the top of the inspection shaft. The water is drawn from the reservoir by two pitcher pumps mounted on a large concrete slab 175 ft. away, so there is no risk of contamination from spillage.

A further supply was obtained by sinking a sump of reinforced concrete into the clay under-bed of the dry stream bed, Wuruma. The sump was filled with clean broken stone and water is raised by a pump 140 ft. away. This was giving a yield of 5,000 gals. per day before the commencement of the rains.

Gumel.—Sinking during the previous two years having

been carried out principally in the west and south of Gumel Emirate, operations this year have been confined to the north-east corner of the emirate—the Sarkin Bai District, which adjoins the French boundary. The Sarkin Bai District is the most sparsely inhabited district in the emirate and consequently the provision of wells is greatly appreciated and is causing virgin and fallow areas of good soil to be brought under cultivation. Immigration from French territory commenced early in the year and is still taking place.

During the period twelve new wells have been brought into production and a total of 2,000 ft. has been sunk and lined. Costs, at about seven shillings a foot, are approximately the same as last year.

Katsina and *Daura*.—Shaft sinking has been continued in the Emirates of Katsina and Daura, resulting in eleven producing wells in the former and six in the latter. In a few wells in Katsina difficulty was experienced due to friable and running sands at depth. One well which struck crystalline rocks was successfully galleried and is now yielding a plentiful supply of water. In Daura the sediments are more compact and sub-artesian rises are being obtained.

Kano.—In the Babura District fourteen new wells were constructed during the period January to June 1935, bringing the total for that area, since work commenced in May 1934, to twenty-four. The deepest well, that at Kanya Babba, is 145 ft., and the shallowest at Jigawa, 27 ft., the total footage sunk this year being some 1,671 ft.

The majority of these wells are in the bush and are provided mainly to assist the agricultural development of the area. To the north of the district the shafts pass through fine-grained sands and mottled clays, belonging to the Chad Series. To the south, at Kanya Babba, there is evidence that the boundary of the Chad Series is in that area, and this is confirmed in the uncompleted shaft near Muna, some two miles south of Kanya Babba, where banded grits are found.

TANGANYIKA

The Imperial Institute has received the following statement from the Government Geologist regarding the work carried out by the Geological Survey during the year ended June 30, 1935.

The work was entirely of an economic nature and consisted of: (1) detailed as well as reconnaissance geological survey of promising gold areas, (2) geological

work on water supply, including the provision of supplies of deep-seated water by boring, (3) the maintenance of the service afforded by the chemical and petrographical laboratory and assay office, (4) the maintenance of the drawing office service for the supply of sunprints and maps.

In regard to the geological work in gold areas, the concentrated field activities of the previous year provided much material for office work in connection with the production of maps and reports dealing with three of the most important gold-bearing regions of the territory, namely, the Lupa, the Musoma and the Saragura (south-west Mwanza) goldfields. During the year under review the geological field-work undertaken consisted of rapid reconnaissance examinations of promising but less known areas, which were carried out as extensively as the limited field staff available would permit. It was found possible also to continue the detailed geological survey of the Musoma District, which had been initiated the previous year, and some 1,450 sq. miles were covered in the south and south-eastern part of the district, this area including four producing gold mines, five prospects and the Serengeti (Complete) Game Reserve.

Other gold areas examined included the Mjombe-Saba Rivers area in the southern portion of the Manyoni District; the Mualezi River, south-west of Tukuyu; and the Kineleli prospect, in the Singida District. None of these is likely to prove of great importance, though the last is of considerable interest geologically since the ore is a garnet-amphibole-quartz-rock containing pyrrhotite as the principal sulphide. The formation, which is banded and contorted, grades to a micaceous quartzite; it is infolded in granite and most probably represents locally metamorphosed relics of ancient impure calcareous and siliceous sediments.

The year 1934 was principally noteworthy for a great campaign of reef development, numerous mining groups commencing operations in the Lupa, and in the northern goldfields of Mwanza and Musoma. It is not expected, however, that reef production will show very marked increase until the developmental programme of the larger companies has been completed. At present the Lupa placer gold still accounts for well over half the total produced in the territory. Gold production for the past three years has been as follows: 1932, £149,864; 1933, £201,866; 1934, £290,647.

The record gold nugget of the territory, which was found in the Kasisi River area (Lupa) early in 1935, contained 125 oz. of gold together with a small amount of quartz.

It is encouraging to record that the production of minerals other than gold shows a decided increase, the value rising from £52,627 in 1933 to £72,979 in 1934. Tin, diamonds and salt all show substantial increases, but mica shows the lowest figure recorded of £1,604 as against £26,954 in 1926. The production of phosphate (bat guano) is recorded during 1934 for the first time, £615 worth having been produced during the year. The discovery of a seam of coal not far from the Lupa goldfield was another important event, since it is highly likely that its proximity to the goldfield will in the near future permit its exploitation.

Among minor minerals numerous deposits of corundum have been recorded by the Survey in the neighbourhood of Dodoma, but so far they have failed to attract prospectors. A beryllium mineral (euclase) has been recorded from pegmatites in a mica mine in the Morogoro District, where the largest crystals on record of this rare mineral have been found. Beryl, also, occurs in most of the mica areas of the territory, but workable deposits have not yet been found. An occurrence of emerald in mica-schist is also reported from the Nguru Hills, Morogoro District, but details are not available. Flake graphite of fair quality occurs in several parts of the country, and from enquiries received by the Survey during the year it would seem that interest in this mineral is re-awakening. An interesting mineral identified by the Survey during the year is andalusite, which may possess some value as a refractory.

The laboratory is equipped for identification of rocks and mineral substances ; for the performance of fire-assays for precious metals ; wet assays for metallic ores ; and chemical examinations of waters, brines, clays, limestones, natural salts, fuels and fertilisers, as well as other miscellaneous materials. The volume of work dealt with by this branch of the Survey shows steady and rapid increase.

A full drilling programme for water was maintained throughout the year, the two Star drilling machines accounting between them for eighteen boreholes with a total footage of 4,815, of which 33 per cent. was in hard crystalline rock. The deepest borehole of 705 ft. was entirely in sedimentary rock. Eighty-two per cent. of these boreholes struck water and the total number of gallons per 24-hour day added to the resources of the territory was nearly 700,000. The greater proportion of this total, though somewhat saline, may be regarded as potable. All these boreholes were for sisal plantations, eleven being in the Tanga Province, where Tertiary formations were pierced, and the remainder in the neighbour-

hood of the Central Railway, where the formations were more varied, ranging from sediments of Karroo and of Jurassic age to gneiss of the Lower Basement Complex.

The Geological Survey now functions as part of the Lands and Mines Department, but its personnel is being increased by the aid of a loan from the Colonial Development Fund so that a more exhaustive exploration of the mineral resources of the territory may be undertaken.

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Report on the Fisheries of Palestine. By J. Hornell. Pp. 106, 10 × 6¾. (London: Crown Agents for the Colonies, 1935.) Price 7*s.* 6*d.* A survey of the marine and fresh-water fisheries and marine industries of Palestine, and recommendations relating thereto.

FORESTRY

General

Report on the Management and Exploitation of the Forests of Ceylon. *Sessional Paper VII*, 1935, *Ceylon.* Pp. 50, 9¾ × 6¼. (Colombo: Government Record Office, 1935.) Price 50 cents.

Annual Forest Administration Report of the Bombay Presidency, including Sind, for the year 1933–34. Part I. Pp. 83, 9½ × 6. Price 10 annas or 1*s.* 1*d.* Part II. Appendices. Price 9 annas or 1*s.* (Bombay: Superintendent, Government Printing and Stationery, 1934.)

Review of the Forest Administration in Burma (including the Federated Shan States) during the five years from April 1, 1929, to March 31, 1934. Pp. 17, 9¾ × 6½. (Rangoon: Superintendent, Government Printing and Stationery, 1935.) Price 6 annas or 7*d.*

Progress Report of the Forest Administration in Coorg for 1933–34. Pp. 32, 9¾ × 6½. (Bangalore: Mysore Residency Press, 1934.) Price Re. 1.

Annual Report of the Conservator, Forest Research Institute, Kepong, Federated Malay States, for 1934. Pp. 15, 13 × 8. (Kepong: Forest Research Institute, 1935.) Mimeographed copy.

Annual Report of the Forestry Department, Nyasaland, for the year ended December 31, 1934. Pp. 24, 13 × 8. (Zomba: Government Printer, 1935.) Price 1*s.*

Annual Report on the Forest Department, Sarawak, for the year 1934. Pp. 10, 13¾ × 8¾. (Kuching: Government Printing Office, 1935.)

Administration Report of the Conservator, Forest Department, Trinidad and Tobago, for the year 1934. *Council Paper No.* 61 *of* 1935. Pp. 20, 13½ × 8¾. (Port-of-Spain: Government Printer, 1935.) Price 16 c.

Annual Report of the Forest Department, Uganda Protectorate, for the year ended December 31, 1934. Pp. 22, 13¼ × 8½. (Entebbe: Government Printer, 1935.) Price Sh. 1/50.

Planting Trees for Special Purposes. Wind-breaks as a Necessity in the Production of Garden, Orchard, and Field Crops. By J. J. Voorendyk. *Farming in S. Africa* (1935, **10**, 256–257, 268).

Control of Forest Insect Pests. Distribution of Parasites in New Zealand. By D. Miller and A. F. Clark. *New Zealand Journ. Sci. and Tech.* (1935, **16**, 301–307).

Veldgewassen in Djaticulturen. By C. Coster and M. S. Hardjowasono. *Tectona* (1935, **28**, 464–487). With English summary. Deals with the influence of agricultural crops in taungya plantations on the growth of teak.

The Control of the Insect Pests of Basket Willows, with Special Reference to the Use of Combined Insecticidal and Fungicidal Washes and to Methods of Application. By H. G. H. Kearns. *Ann. Rept. Agric. and Hort. Res. Sta., Long Ashton, Bristol,* 1934, pp. 126–146.

The Control of the Brassy Willow Beetle (*Phyllodecta vitellinæ* L.), with Special Reference to the Use of Dusts. By H. P. Hutchinson and H. G. H. Kearns. *Ann. Rept. Agric. and Hort. Res. Sta., Long Ashton, Bristol,* 1934, pp. 147–149.

Timbers

Programme of Work of the Forest Products Laboratories of Canada for 1935–1936. Pp. 88, 10¾ × 8½. (Ottawa: Forest Products Laboratories, 1935.) Mimeographed copy.

Timber: Its Structure, Properties, Seasoning and Preservation. *Forestry Pamphlet No.* 3, *Trinidad.* Pp. 18, 8½ × 5½. (Trinidad: Government Printer, 1934.) Price 12 cents.

Some Local Timbers. By D. K. S. Grant. *Bull. Forest Dept., Tanganyika.* Pp. 46, 9½ × 6. (Dar es Salaam: Government Printer, 1934.) Price 2*s*.

The Identification of the Principal Commercial Australian Timbers other than Eucalypts. By H. E. Dadswell and A. M. Eckersley. *Bull. No.* 90, *Counc. Sci. Indust. Res., Australia.* Pp. 102 + 56 figs., 9½ × 6. (Melbourne: Council for Scientific and Industrial Research, 1935.)

The Identification of Wood by Chemical Means. Part 2. Alkalinity of Ash and Some Simple Chemical Tests for the Identification of the Coloured Woods of the Genus *Eucalyptus.* By W. E. Cohen. *Pamphlet No.* 53, *Div. For. Prod., Counc. Sci. Indust. Res., Australia.* Pp. 23, 9½ × 6. (Melbourne: Council for Scientific and Industrial Research, 1935.)

The Starch Content of Some Australian Hardwoods in Relation to their Susceptibility to Attack by the Powder Post Borer, *Lyctus brunneus* Stephens. By J. E. Cummins and H. B. Wilson. *Journ. Counc. Sci. Indust. Res., Australia* (1935, **8**, 101–110).

Veneers and their Production. By W. C. Potter. *Journ. Roy. Soc. Arts* (1935, **83**, 597–615).

Gums and Resins

Het Harsonderzoek in Nederlandsch-Indië, tevens eerste Overzicht der Nederlandsch-Indische Harsen, meer in het Bijzonder der Damarsoorten. By F. H. Endert. *Korte Med. No.* 51 *v. h. Boschbouwproefsta., Dept. v. Econ. Zaken in Ned.-Indië.* Pp. 90, 9¾ × 7. (Buitenzorg: Archipel Drukkerij, 1935.) Summary in English. Deals with resins available in the Netherlands East Indies, their botanical identity and commercial importance, districts in which they occur and their marketing. Surveys the investigations carried out on the resins and makes suggestions as regards future investigations.

Identification and Analysis of Lac. By R. Bhattacharya. *Tech. Paper No. 2, London Shellac Res. Bureau.* Pp. 28, $8\frac{1}{4} \times 5\frac{1}{2}$. (London: India House, 1935.)

Problems of the Chemistry of Lac. By A. Karim. Pp. 12, $8\frac{1}{2} \times 5\frac{1}{2}$. Reprint from the *Journal of the Oil and Colour Chemists' Association.*

Tanning Materials

Handbook of the Tanning Trade of South India. By A. Guthrie. *Bull. No. 40, Dept. Indust., Madras.* Pp. 116, $9\frac{3}{4} \times 6\frac{1}{4}$. (Madras: Superintendent, Government Press, 1934.) Price Rs. 3–6.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

The Diseases and Curing of Cacao. By H. R. Briton-Jones, D.Sc., Ph.D., D.I.C., A.R.C.S. Pp. x + 161, 9 × 6. (London: Macmillan & Co., Ltd., 1934.) Price 10*s*.

The author states in his preface that this book has been written primarily for agricultural officers and cacao planters. The aim has been to enable them to diagnose a specific disease from macroscopic characters under field conditions and to control it. Stress is laid on the fact that the crop or host plant can in general withstand a wider range of soil and meteorological conditions than the parasite. From this it follows that "in a large number of cases disease can be controlled by modifying agricultural practices in such a manner as to bring about conditions which are within the range of tolerance of the host and outside that of the parasite."

The section on the two very destructive diseases, pod rot and canker, caused by *Phytophthora palmivora*, affords a good example of the mode of dealing with the subject. After descriptions of the two diseases a lengthy discussion follows in which it is pointed out that their incidence depends largely on humidity within the cacao, due to lack of efficient drainage, too dense canopy either of the cacao trees themselves, or of shade trees as well. This leads to a discussion of methods of pruning, shade reduction, drainage, etc. The point is also made that canker may alter the life cycle of the tree, forcing it to reach its maximum bearing at an unduly early age and then go into a rapid decline to a premature death, entailing replacement and thus causing crop losses which are difficult to appreciate fully.

Similarly in the chapter on root diseases the main diseases are described and their methods of control discussed on broad lines. Some of the suggestions made will probably be effective in stimulating thought and encouraging experimental work. Thus after a lengthy discussion of the problem of accounting for the frequent incidence of various root diseases in freshly cleared and planted areas of forest land, the author concludes that the whole question must be considered " in the light of the assumption that the fungi responsible are present in the soil beforehand," and that the clearing fundamentally alters conditions for both green plants and soil fungi. Some of the latter may then grow in large quantities on the stumps of the forest trees, and " it is possible that their staling products are dispersed into the surrounding soil and have a toxic effect on the finer rootlets of the crop that is being grown." Later, when the stumps are completely rotted, the " wave of life " of the harmful fungus will subside. This leads to the suggestion that in preference to expensive stumping and burning, even where considered an economic proposition, " it might be more economical to grow temporary and immune crops for a few years while the course of fungi like *Rigidoporus microporus* [a cause of root disease in cacao, Para rubber, tea, etc.] is running its course, and to plant the permanent crop later."

Witches' broom disease of cacao has a section to itself, most of which is reproduced from the joint paper by the author and Professor Cheesman in *Tropical Agriculture* (1930, **8**, 78–89).

The final section on the preparation or curing of cacao describes the objects of the process and the methods practised in various countries, reviews previous investigations and makes suggestions for modification of the early stage of the process to ensure a more nearly simultaneous death of the beans and thus more uniformity in results. The volume is well illustrated and has an extensive bibliography.

DISEASES OF THE BANANA AND OF THE MANILA HEMP PLANT. By C. W. Wardlaw, Ph.D., D.Sc., F.R.S.E. Pp. xii + 615, 9 × 6. (London: Macmillan & Co., Ltd., 1935.) Price 30*s*.

The banana is subject to two diseases of prime economic importance. Although native to the Old World, the commercial production of bananas is mainly in the Caribbean area, the West Indies and parts of Central and South America. Here the continued cultivation of the Gros Michel or Jamaica banana, the variety most suited for

modern bulk transport, is menaced by Banana Wilt or Panama Disease, due to a soil-inhabiting fungus, to which the other important commercial variety, the Cavendish, Chinese or Canary banana, is practically immune.

In Australasia, Fiji and other eastern countries, including Egypt, banana cultivation has suffered very severely from the ravages of Bunchy Top disease, due to a virus. The Canary banana is particularly susceptible to this disease, and no variety as yet is known to be immune or even highly resistant.

There are several other diseases of the growing banana, but they are of minor economic importance. In addition, as the fruit is carried long distances in a living condition, there are all the troubles which are conveniently grouped as storage diseases, many of them due to fungi, others to physiological disturbances.

The task which Dr. Wardlaw set himself was to bring together an account of all these diseases in a form to "provide useful information for the practical agriculturist, the student and the scientific investigator."

Dr. Wardlaw is particularly well equipped for this task, having been for the last six years or so the Pathologist for banana-research at the Imperial College of Tropical Agriculture, Trinidad. He has travelled extensively in the banana-growing regions of the West, and in addition to ordinary field and laboratory facilities has had the special Low Temperature Research Station at the disposal of himself and a colleague—a Plant Physiologist—for work on storage questions. As a result, although he has made full use of the information obtained by other workers—the bibliographical appendix contains 559 references—a great part of the book is based on first-hand knowledge, and many of the numerous illustrations are also original.

The result is a volume which is of the highest value to the agriculturist, whether planter or official, the mycologist, and to all concerned in any way with the commercial production and transport of bananas.

The Physiography and Vegetation of Trinidad and Tobago. A Study in Plant Ecology. By R. C. Marshall, B.Sc., M.A., Dip. For. *Oxford Forestry Memoirs*, Number 17, 1934. Pp. 56, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: The Clarendon Press; London: Mr. Humphrey Milford, Oxford University Press, 1934.) Price 6*s*.

Part I of this Memoir gives a very good summary of the history, topography, geology and soils, and the meteorology of Trinidad and Tobago. Sketch maps are freely used to illustrate the main features in all three

sections. In the case of the rainfall there are not only maps of both islands showing the annual distribution, but also one for each month. The annual range, and the diurnal variation, of temperature and relative humidity, are shown by graphs. As a result the salient physiographical features of the islands can be much more easily and clearly grasped than by having to pore over elaborate tables of statistical returns.

Part II deals with the types of vegetation. As the author remarks, " of the three main types—forest, grassland and desert—desert conditions are absent; the amount of grassland is extremely limited and the natural vegetation of nearly all the colony is forest. . . . To distinguish the various forest types which obtain under tropical conditions such as are found in Trinidad and Tobago is a very difficult problem."

The method adopted for determining the composition of many forest areas was strip surveying, all the trees for half a chain on each side of the line being recorded by species and girth, and the soil, down to 1 ft., noted every chain. From the information so obtained, correlated with rainfall and other data, the areas under the major forest types were established. Descriptions are given of these, with an enumeration of the dominant, sub-dominant and lower story species composing each type.

Brief sections on secondary vegetation, and on forestry, agriculture and land allocation add to the general interest of the memoir.

In addition to the maps there are some twenty good illustrations of representative forest scenes.

NATIVE TREES OF AUSTRALIA. By James Wales Audas, F.F.Sc., F.L.S., F.R.M.S., F.R.S.A. Pp. 296, $9\frac{1}{4} \times 6\frac{1}{4}$. (Auckland, Christchurch, Dunedin, Wellington, N.Z., Melbourne, Sydney, London: Whitcome & Tombs, Ltd.) Price 21*s*.

An illustrated handbook dealing with the plants met with in the countryside is always welcome to an educated public, and in Australia, which, according to the author, possesses some 1,500 species of trees alone, such help to an understanding of the flora must be greatly appreciated. The volume under notice does not afford a key to the identification of all the tree species—a formidable task—and the author's object is to supply a short, popular description of a selection of the principal trees of the Australian forest in a manner illustrating their variety, beauty and value. Assuming that the enquirer will have some knowledge of the name of the tree met with, he will

find the present book a most helpful and interesting guide, and one which he will be induced to read for pages beyond the one concerning his immediate quest.

Introductory chapters, in which much valuable information is given, are devoted to the Australian forest, the principal trees of Australia and the forest in relation to agriculture. The tree species are then dealt with in groups, e.g. eucalyptus trees (described in sections as bloodwoods, boxes, tallow woods, gums, peppermints, etc.), myrtles, mangroves, conifers, acacias, while a large and important section is taken up with descriptions of numerous other trees arranged alphabetically according to their botanical genera. The trees are dealt with under their botanical names (which are translated, adding greatly to their interest), the common name being also given. Details are furnished regarding the habitat and size of the tree, the characters of leaves, flowers and fruits, and as to the uses, if any, to which the various parts are put. The book is abundantly provided with excellent photographs and line drawings, and there are several coloured plates, including representations of some of the more striking timbers. A glossary of the botanical terms used in the text is provided.

The Practice of Silviculture, with Particular Reference to its Application in the United States of America. By Ralph C. Hawley. Pp. xv + 340, 9 × 5¾. Third Edition, Rewritten and Reset. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 20s.

The preparation of a third edition of this book (first published in 1921), which is concerned primarily with the application of silvicultural methods to the forests of the United States, is justified by the author on the grounds that the view is gaining strength each year that timber crops in America must be purposely grown if a permanent supply of forest products is to be maintained. This increasing conviction is attributed to the enlarged activity of the Government and other agencies in applying silviculture in the management of the woods.

The book has been rewritten in order to bring the text up to date without substantially increasing its volume. In the first chapter a general consideration of the subject discusses production in managed and unmanaged forests and the purpose, scope and cost of silviculture. This serves as an introduction to the rest of the work, which comprises twenty-two chapters of which, it may be noted, nine are devoted to a study of forest protection, notably

against fire. This latter subject is dealt with at such length with the object of impressing upon the student the fact that protection of the forest is an essential part of silviculture and often spells the difference between profitable and unprofitable crops.

The earlier sections of the book deal with standard silvicultural practices. The first eight chapters are concerned with methods of reproduction, including high forest methods (clear cutting, seed tree, shelterwood and selection), which produce forests originating from seed, and coppice forest methods (coppice and coppice with standards), producing forests originating wholly or mainly from sprouts and suckers. The questions of cuttings (fellings) and thinnings are then considered and chapters on methods of controlling cuttings and the disposal of slash lead to the sections dealing with forest protection. The work is a clearly and carefully arranged text-book, and its value to students should be by no means confined to those of the United States. As in so many books of this class, a useful bibliography follows each chapter.

LOGGING—PRINCIPLES AND PRACTICES IN THE UNITED STATES AND CANADA. By Nelson Courtlandt Brown. Pp. xvii+284, 9×6. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1934.) Price 21*s.* 6*d.*

This excellent and well-illustrated book is intended as an introduction to the principles and practices of logging as carried out in the United States and Canada. The forests of the United States, which even now comprise about one-quarter of the total area of the country, have been grouped by the Forest Service into eight broad major regions, varying much in geographical and topographical characters and exhibiting distinctive logging and utilisation problems. In certain regions, e.g. in the East, similar types of forest and logging methods occur in two or more regions; hardwood logging, however, is concentrated largely in the Mississippi delta, the Appalachians and adjacent sections of the south-east regions. The author, therefore, has aimed at producing a text-book for the students of forest schools who have had little or no opportunity of observing logging practice in more than one region. Special attention, however, has been given to the conditions existing on the Pacific Coast, where most of the remaining virgin timber of North America occurs, and to the south-east, where the largest forest areas of potentially important forests of the United States are to be found. The work is based largely on personal studies of the author in many parts of the United States and Canada.

In the first part of the book a series of chapters deal with forest utilisation, forest resources, forest labour and housing, felling and preparation of logs for transport and selective logging. The discussion of forest utilisation forms a useful and interesting introduction to the succeeding chapters, which are written in a clear, straightforward style, well adapted to the requirements of students. The second part, which deals with varying logging practices, is of special interest and value. A general account is given of the characteristic methods of logging adopted in each of the eight forest regions referred to above, and, since it is desirable to consider separately subdivisions of these areas, some sixteen regions in all receive individual treatment : the Pacific Coast region includes British Columbia, and the General Eastern forest region includes as a sub-region Eastern Canada. Each of these regions is briefly described with reference to the chief commercial types of forest, the leading and secondary species concerned and stands per acre ; stumpage values and periods of logging ; labour and camp organisation ; climatic and other factors affecting logging operations ; felling practices, loading and transportation. This section of the book furnishes most interesting reading. The practical needs of the student are well supplied in an extensive, classified bibliography and a convenient hand-list of tree species giving common and botanical names. The book is admirably produced.

MANAGEMENT OF AMERICAN FORESTS. By Donald Maxwell Matthews, B.A., M.S.F. (American Forestry Series.) Pp. xv + 495, 9 × 6. (London : McGraw-Hill Publishing Co., Ltd., 1935.) Price 30*s*.

The author of this book is remembered in this country as the organiser of a forestry department in British North Borneo and later as the manager of an important company in that State engaged in the commercial development of timber areas which were worked under the Code prepared by him. The present volume, however, is directed solely to the subject of the title. In a prefatory note Prof. Walter Mulford, the consulting editor, points out that each forest property in the United States presents its own set of conditions, and that for a long time yet " the American forest manager must feel his way almost as though intensive European forestry had never existed."

It is no doubt specially true that the American forests as they now exist present " most interesting management problems," and that business planning must form the essential basis of dealing with them, leaving until later the application of " the refinements of silviculture."

This is the text on which Prof. Matthews has written his book, which is addressed both to the forest manager and the college student. The subject is dealt with from the technical and financial standpoints and on the basis that the practice of forestry in the United States must to a great degree be concerned with the production of continuous crops of merchantable timber. The technical problems encountered arise from the fact that two distinct types of forest property are involved, viz. properties carrying stands of trees of even age, and properties carrying all-aged stands. In both cases the growing stock forms the chief capital investment and financial success of exploitation rests upon sound technical practice in managing this capital.

The book is written in two parts, the first dealing with the foundations of Forest Management, and the second with the Financial Aspects of the subject. In the former series of chapters the author discusses the various matters which must receive attention in the technical organisation for continuous lumber production of a hitherto unregulated forest property, and in doing so he emphasies the outstanding importance of a regulated growing stock and aims at suggesting simplicity of technique in achieving that regularity.

The financial section of the book needs close attention. Commencing with an outline of the financial problems involved in American forests, it deals with the nature of capital and income in forest business, valuation questions, forest taxation, and insurance and appraisal of damage. There is an appendix containing a discussion of the promotion and organisation of forest industry, a note on the derivation of compound interest formulas, and tables of compound interest. A useful bibliography completes a valuable work.

Die Arbeiterwanderungen in Südostasien. Eine wirtschafts- und bevölkerungsgeographische Untersuchung. By Dr. Karl Josef Pelzer. Pp. vi + 126, $8\frac{3}{4} \times 5\frac{3}{4}$. (Hamburg: Verlag Friederichsen, de Gruyter & Co. m.b.H., 1935.) Price Rm. 3.50.

This is a treatise on the supply of labour for plantation work in Assam, Burma, Ceylon, British Malaya and Sumatra, and the migration of workers into these countries from over-populated districts of India proper, China and Java. The author deals with the conditions which impel the labourers to leave their native countries, the methods and organisation of their recruitment, and the routes and transport services by which they proceed to their new

fields of employment. A mass of statistical detail is supplied, and a copious bibliography is appended to the work.

Dr. Pelzer has explored his subject with great thoroughness, and his book should be of much interest to administrative officers, sociologists and others concerned with the question of tropical labour.

Problems in Soil Microbiology. By D. Ward Cutler and Lettice M. Crump. Pp. vii + 104, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Longmans, Green & Co., 1935.) Price 9*s*.

This book, which is one of the series of Rothamsted Monographs on Agricultural Science, is not intended to be in any sense a text-book of soil microbiology, but is, rather, a discussion of a few of the more important of the many inter-related problems of the micro-organic life of the soil. It is recognised that the activities of any one organism or group of organisms in the soil depend upon those of the remainder of the soil population, and reliable knowledge of the whole problem can only be attained by the laborious process of tracing out the life history of each organism. This book gives the results of some attempts made to disentangle these complicated relationships.

The first chapter contains a general discussion of the soil as a habitat for micro-organisms, showing that, as a result of natural conditions and of agricultural practice in the past, it is so well suited to this purpose that the micro-population is to a large extent unspecialised. Hence almost any substance which finds its way into the soil, either naturally or as a result of cultivation, is ultimately incorporated into the general soil economy.

The next section deals with the bacterial portion of the soil micro-organisms, methods of counting bacteria, variations, due to different causes, in total numbers and in relative abundance of species, and the reactions of the bacteria to specific chemical compounds. The third and fourth chapters consider the relation of soil bacteria to nitrite, showing that by far the majority of the species found can react with nitrite in some way. The connection between the bacterial population, both as regards numbers and species, and the evolution of carbon dioxide from the soil are also considered.

The next two sections are concerned with the protozoa of the soil, these organisms being considered both in pure culture and as found in the soil, while the final chapter gives a general discussion of the complicated interactions of the various types of micro-organisms.

In view of the changing conditions, methods and materials of agriculture during recent years, the authors'

concluding remarks should be borne in mind by all concerned with the theory and practice of agriculture. In the past, empirical methods have led to the maintenance of the soil as an eminently suitable environment for all the many types of soil micro-organisms, and hence to the retention of a reasonable level of fertility by keeping up the normal balance of the soil population. The safeguarding of this balanced condition of the soil is one of the duties of the new generation of agriculturists, and this can only be attained by increased knowledge linked with its application to practice in the field.

Biological Processes in Tropical Soils with Special Reference to Malaysia. By A. Steven Corbet, B.Sc., Ph.D., F.I.C. Pp. xiv + 156, $8\frac{1}{2} \times 5\frac{1}{2}$. (Cambridge: W. Heffer & Sons, Ltd., 1935.) Price *7s. 6d.*

Considerable progress has been made in elucidating some of the problems of the soil scientist and the agriculturist in temperate climates, but it is only during recent years that there has been any widespread recognition of the fact that soil and climatic conditions in tropical regions differ so widely from those of the temperate zones, that the conclusions reached from work carried out in the latter cannot be applied to any appreciable extent to the tropics. This is particularly true as regards variations in composition due mainly to the activities of micro-organisms, especially those affecting the reactions of the organic matter of the soil. The present book has for its main theme the processes of change of composition and condition in the tropical soils of Malaysia, chiefly from the standpoint of rubber cultivation.

Nearly a third of the book is occupied by a general outline of the geology, probable mode of formation and physical character of the constituent parts of Malaysia, and the flora and fauna characteristic of the different parts of the region. This is followed by chapters dealing briefly with the various types of micro-organisms found in tropical soils and their relative abundance, and with the typical curve of increase and decline in bacterial population in cultures.

The next three chapters may be regarded as forming the most important section of the book. They deal in some detail with the organic matter of the soil, its formation and decomposition and the part played by micro-organisms in these processes, with the transformations of nitrogen compounds and with Jenny's law relating the nitrogen and organic matter contents of the soil to the mean annual temperature and the humidity.

The final chapter is devoted to some practical applications of these ideas in connection with rubber cultivation, such as effects of complete clearing, burning of cleared land, various cover crops and manuring. There is also a clear exposition of the pros and cons of the so-called Birkemore system of allowing a rubber plantation to develop a more or less natural undergrowth, as opposed to the clean-weeding system.

There is an appendix of standard methods for the examination of soils, but this hardly contains sufficient detail to serve as a practical guide to anyone wishing to carry out such an examination.

A COMPREHENSIVE TREATISE ON ENGINEERING GEOLOGY. By Cyril S. Fox, D.Sc., M.I.Min.E., F.G.S. Pp. xv + 392, $9\frac{3}{4} \times 6$. (London: The Technical Press, Ltd., 1935.) Price 35*s*.

This book is a considerably enlarged edition of the author's *Civil Engineering Geology*, which was first published in 1923. Whereas, however, the original work contained only 144 pages, the present work contains 392, and has been entirely rewritten.

For convenience, the author has divided the subject matter into three roughly equal parts, consisting of six chapters each, dealing with building materials, field operations and water supply. The first few chapters of each part are given to the more theoretical aspects of the subject, the subsequent chapters being of a more practical nature, particularly from the engineer's point of view. Among such practical subjects dealt with may be mentioned the choice of building materials, quarrying and tunnelling, retaining and protecting walls, building sites, surface and underground water supplies, and the quality of water, all of which are of much importance from the engineer's point of view.

The book is well illustrated by some eighteen photographic plates, seventy line-drawings and twenty-five photomicrographs, and is likely to prove of much interest and value to students of engineering geology.

STRUCTURAL GEOLOGY WITH SPECIAL REFERENCE TO ECONOMIC DEPOSITS. By Bohuslav Stočes and Charles Henry White. Pp. xv + 460, $8\frac{3}{4} \times 5\frac{3}{4}$. (London: Macmillan & Co., Ltd., 1935.) Price 25*s*.

This book is designed to meet the requirements of mining geologists and engineers in the practical aspects of structural geology. Special emphasis is consequently

given to those sections of applied geology that deal with the form, position and mode of occurrence of the various types of economic deposits, a knowledge of which is essential as a basis upon which to plan and carry out exploration, as well as to predict the probable extent and value of any deposits that may be discovered. It is also of importance in the selection of a method of mining and in the laying out of the underground work, and in other ways.

The book is essentially an elaboration of a similar work published in Czech and German by Dr. Stočes, who is Professor of Geology in the Czechoslovakian National School of Mines. The original text, however, has been rearranged and expanded, while the number of illustrations has been considerably increased. Indeed, the illustrations now number more than 660, and include beautifully reproduced photographs (many of British and Bohemian scenery), sections and diagrams, the whole forming what may be described as an excellent picture gallery of geological structures.

It is, of course, almost inevitable that the text should be broken up by so many figures; but the work as a whole is to be recommended as forming an attractive introduction to the study of tectonic geology.

The Geology of Burma. By H. L. Chhibber, Ph.D., D.Sc., F.G.S., F.R.G.S., with contributions by R. Ramamirtham, M.A. Pp. xxviii + 538, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Macmillan & Co., Ltd., 1934.) Price 30*s*.

This volume gives a detailed account of the geology of Burma, and contains much new information, including many original field observations. With its companion volume on the mineral resources of Burma, noticed below, it will prove a valuable work for study and reference.

The volume is divided into three parts dealing with the physical geography and geology, the stratigraphy and the igneous activity of the country. The first part (pp. 1–109) deals with the broad physical divisions and accounts for river systems, lakes, earthquakes, hot springs, mud volcanoes, denudation, limestone caves and the coastline, which extends for some 1,200 miles from north of Akyab to Victoria Point. This is followed by a comprehensive statement (pp. 110–285) of the historical geology of Burma, furnishing, as it does, an almost complete record of Palæozoic and Mesozoic rocks in the Federated Shan States, and of the Tertiary rocks in the Central Belt. A useful correlation table of geological formations is given on pp. 113–116, the value of which is further increased by

two appendixes contributed by J. B. Scrivenor and P. Evans dealing with the correlation of the geology of Burma with that of Malaya and Assam respectively.

The third portion of the book (pp. 286–518) deals with the origin and history of Burmese igneous rocks, their variations in time and space and their relation to tectonic movements. Petrographical descriptions are given in some detail, and are supplemented by numerous chemical analyses and variation diagrams.

At the end of each chapter a list of references additional to those given in the text provide a useful feature. The volume is well illustrated, the illustrations including three folding geological sketch maps of Burma, the Northern Shan States and the Mergui and Tavoy districts.

The author is to be congratulated on producing such a handy and useful manual of Burmese geology, and thus making readily available much information that has hitherto been widely scattered in scientific publications.

The Mineral Resources of Burma. By H. L. Chhibber, D.Sc., Ph.D., D.I.C., F.G.S., F.R.G.S. Pp. xv + 320, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Macmillan & Co., Ltd., 1934.) Price 18*s*.

This book is a companion volume to the one noticed above, and the author is to be congratulated on having made two separate volumes of this work. Geology and mineral resources are too often coupled in one volume, with results which are far from satisfactory from the economic standpoint.

After a brief introductory statement, the minerals are dealt with in fifteen chapters. Petroleum is the chief mineral product, and the chapter devoted to this is contributed by Dr. L. Dudley Stamp. Little is said about the reserves of oil available or of the future prospects for the fields, and the statistics given do not go beyond 1930.

The lead-silver-zinc deposits of Bawdwin and of Mawsön are briefly but adequately dealt with, and many other occurrences are mentioned. In this chapter the author uses the three names zinc-blende, blende and "sphælerite" for the same mineral, the last-mentioned being incorrectly spelt.

Perhaps the best chapters in the book are those on gemstones, which include ruby, sapphire, spinel, jadeite, amber and many less abundant varieties. The author has worked for years on these deposits and his account is very interesting and informative, especially the chapter on jadeite, which incidentally is the longest in the book.

Interesting chapters on soils, water supply and stones

of various kinds have been included, and the book is to be recommended as a good source of information on all the many minerals known in this important mineral province.

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER, III. LE ZINC, LE PLOMB, L'ARGENT, LE CUIVRE, L'OR, LES MINERAIS RADIO-ACTIFS, LE MICA, LES PIERRES PRÉCIEUSES, SUBSTANCES DIVERSES. Pp. 394, $9\frac{3}{4} \times 6\frac{1}{4}$. (Paris : Société d'Éditions Géographiques, Maritimes et Coloniales, 1935).

This is the third of an important series of systematic volumes, issued by the Bureau d'Études Géologiques et Minières Coloniales, on the mineral resources of the French colonies, the earlier publications having already received notice in this BULLETIN (1932, **30**, 528 ; 1934, **32**, 191 and 507).

Each subject is the work of a specialist, but a considerable amount of descriptive and general information is incorporated. For instance, the section on precious stones commences with a good account of their general characteristics and necessary physical properties before passing on to the various gemstones of the French colonies. In each section the mode of occurrence and geology of the deposits are dealt with fully. A useful summary of the trend of world markets in recent years is also given for each commodity.

The first section of 115 pages, by F. Blondel, deals with lead, zinc and silver in considerable detail. This is followed by sections of about fifty pages each on copper and gold by Pierre Lion and P. Delaitre respectively. These chapters are illustrated by a valuable series of maps specially drawn to show mining localities and, in addition, there are tables giving the latitude and longitude of all the principal occurrences in the French colonial empire. Then follow sections on radio-active minerals by Professor H. Buttgenbach, of the University of Liége, and on mica by P. Chomette. There is a particularly detailed account of the precious, semi-precious and ornamental stones by A. Lacroix amounting to nearly sixty pages.

In the concluding section, under the heading " Substances of Secondary Importance," F. Blondel deals briefly with aluminium, asbestos, antimony, arsenic, barium, bromine, diatomite, mercury, nitrates, platinum, pyrite, salt, potash and mineral waters in the space of forty-two pages, of which eleven are devoted to mineral waters.

The volume is well printed and the half-tone plates are particularly good. Bibliographies are provided for each section of the work and a useful index of place names is

included. The valuable series to which this volume belongs will doubtless form the standard work of reference on the mineral resources of the French colonial empire for some time to come.

THE BOOK OF STAINLESS STEELS, CORROSION-RESISTING AND HEAT-RESISTING CHROMIUM ALLOYS. Edited by Ernest E. Thum. Second Edition. Pp. xii + 787, 9 × 6. (Cleveland, Ohio : The American Society for Metals, 1935.) Price $5.

The present volume is a valuable addition to the literature of stain-resisting, high-chromium alloys, some of which are classified as steels merely as a matter of convenience.

All the commercial unstainable ferrous alloys used in American practice are taken into account, including the high-carbon chrome cutlery steels, the important chrome-nickel-iron series, and other alloys, such as the "Rezistals," "Stellite" and "Illium." The metallurgy, treatment and properties of these alloys are dealt with, and much valuable information is given regarding their uses.

The book is divided into six parts and twenty-two chapters, the chapters being sub-divided into seventy-four sections, each section being taken by an author who is a specialist in his subject. Such an arrangement inevitably leads to some discontinuity and differences of opinion, but brings together a greater volume of expert knowledge than would be possible if the compilation on the different subjects had been attempted by one author.

The book contains a vast amount of information, and should be of very considerable value to all those interested in the manufacture and rapidly growing use of these alloys. The fact that a second edition of such a voluminous work has been produced so soon after the publication of the first (1933), and that references to work carried out in 1934 and 1935 are now included, shows not only that the book meets a need, but also that it is being kept up to date.

CRUSHERS FOR STONE AND ORE. Their Development, Characteristics and Capabilities. By William T. W. Miller, M.Inst.C.E., M.I.Mech.E. Pp. ix + 234, 8¾ × 6. (London : Mining Publications, Ltd., 1935.) Price 15*s*.

This book is designed to supply the needs of those mining and quarrying engineers who use and maintain crushers, which, as is so often the case, are located far away from the resources of the makers' works. The author, who for twenty-five years was engineer-in-charge

of Messrs. Hadfield's crusher department, is well qualified for the task of writing such a book as this, and in it he has compressed much useful information regarding the construction, development, characteristics and capabilities of various stone and ore crushers, including those of the jaw, gyratory, rolls, disc and swing-hammer types.

The book is based on a series of articles previously written by the author in well-known technical journals. It points out that numerous varieties of crushers have been marketed from time to time, and gives some practical advice respecting the choice of a crusher for any particular purpose. No details are given regarding the sizes and outputs of various crushers, as such information is readily obtainable from the catalogues of the manufacturers.

As a sound practical guide, the book can be safely recommended to those interested in the control and maintenance of machinery used for crushing purposes.

Enamels. The Preparation, Application and Properties of Vitreous Enamels. By Andrew I. Andrews, B.S., M.S., Ph.D. Pp. xviii + 410, 9 × 6. (Champaign, Illinois : The Twin City Printing Co., 1935.) Price $5.50.

The author is to be congratulated on the production of this comprehensive work, which is a welcome addition to the somewhat sparse and scattered literature on an important subject.

The opening chapters deal with the history and properties of porcelain enamels and the fundamentals underlying the formation of these somewhat complex silicates. Two chapters are then devoted to the metallurgy of cast iron, sheet iron and sheet steel, and the preparation of their surfaces for enamelling. These demand special notice for the thorough way in which the subject is treated, due prominence being given to the theory of cleaning and pickling.

Next follow two chapters on enamel calculations and compositions, which are admirably presented, and whose value is enhanced by the inclusion of a set of charts for converting raw materials to equivalents and batches to melted compositions.

The individual chapters on frit making, the application of the enamel and its control and firing, are each written in a very comprehensive manner.

The work is well indexed and contains numerous references to original papers. It may be recommended as an informative and well-written treatise, and should find a place in the library of all who are in any way connected with this rapidly expanding industry.

It is, perhaps, worthy of note that the American Ceramic Society and the Porcelain Enamel Institute commend this "valuable contribution to the technology of the porcelain enamel industry."

THE PRINCIPLES OF MOTOR FUEL PREPARATION AND APPLICATION. By Alfred W. Nash, M.Sc., M.I.Mech.E., F.C.S., F.Inst.Fuel, and Donald A. Howes, B.Sc., Ph.D., A.M.I.P.T. Volume II. Pp. xiv + 523, 9¾ × 6. (London: Chapman & Hall, Ltd., 1935.) Price 30*s*.

The second volume of this work fully satisfies the expectations which were raised by the publication of the first volume, reviewed in this BULLETIN (1934, **32**, 630).

The first chapter deals with the analysis of motor fuels, and includes a critical examination of methods. The important tests of anti-knock value, volatility and gumming tendency are considered in separate chapters, and a further chapter is devoted to the consideration of sulphur in motor fuels. The remainder of the book includes interesting chapters on internal combustion engines; automotive Diesel engines and Diesel oils; and aviation fuels. Standard specifications for motor fuel, and the properties of motor fuels marketed in different countries, are also considered. Comprehensive references are given to literature on the subject, and there is an appendix of useful tables, etc.

A few misprints are noticeable, and some of the statistics in the appendix are not as up to date as they should be. These, however, are minor defects, and do not detract appreciably from the value of the book to those interested in internal combustion engines and their fuels. Apart from its value to the technician, the book contains much that is of interest to the layman and is written in a very clear and readable manner.

BOOKS RECEIVED FOR NOTICE

A SHORT HISTORY OF THE GOLD COAST. By W. E. Ward, M.A., B.Litt. Pp. ix + 241, 7¼ × 4¾. (London: Longmans, Green & Co., 1935.) Price 3*s*. 6*d*.

THE REFRIGERATED GAS-STORAGE OF APPLES. By Franklin Kidd, M.A., D.Sc., and Cyril West, M.A., D.Sc. (Food Investigation Leaflet No. 6.) Pp. 12, 9½ × 6. (London: Department of Scientific and Industrial Research, 1935.) Gratis.

SWEET MANUFACTURE. A PRACTICAL HANDBOOK ON THE MANUFACTURE OF SUGAR CONFECTIONERY. By N. F. Scarborough, A.M.I.Mech.E. Pp. xi + 116, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill, Limited, n.d.) Price *7s. 6d.*

THE USE AND MISUSE OF LAND. By R. Maclagan Gorrie, D.Sc., F.R.S.E. Oxford Forestry Memoirs No. 19. Pp. 80, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: Clarendon Press, 1935.) Price *6s.*

CANADIAN WOODS: THEIR PROPERTIES AND USES. By T. A. McElhanney and Associates in the Forest Products Laboratories of Canada. Pp. xv + 345, $9\frac{3}{4} \times 6\frac{1}{2}$. (Ottawa: The King's Printer, 1935.)

FOREST TREES AND TIMBERS OF THE BRITISH EMPIRE. III—FIFTEEN SOUTH AFRICAN HIGH FOREST TIMBER TREES. By L. Chalk, M.A., D.Phil., M. M. Chattaway, B.Sc., M.A., J. Burtt Davy, M.A., Ph.D., F. S. Laughton, B.Sc., M. H. Scott, B.Sc. Pp. 103, $9\frac{1}{2} \times 6$. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1935.) Price *7s. 6d.*

FARM SOILS. THEIR MANAGEMENT AND FERTILIZATION. By Edmund L. Worthen, M.S. Pp. xiii + 468, $8 \times 5\frac{1}{2}$. Second Edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 13*s.* 6*d.*

COLLOIDS IN AGRICULTURE. By C. E. Marshall, M.Sc., Ph.D. Pp. viii + 184, $7\frac{1}{2} \times 5$. (London: Edward Arnold & Co., 1935.) Price *5s.*

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER. IV. LE PHOSPHATE. Pp. 207, $9\frac{3}{4} \times 6\frac{1}{4}$. (Paris: Société d'Éditions Géographiques, Maritimes et Coloniales, 1935.) 20 francs.

DE EDELSTEENEN. By Dr. A. Willemse. Pp. 112, $9\frac{1}{2} \times 6\frac{1}{4}$. (Eeckeren, Antwerp: Drukkerij Constant van Hoof, 1935.)

INDUSTRIAL AND MANUFACTURING CHEMISTRY. Part II, Inorganic—A Practical Treatise. Vol. I. By Geoffrey Martin, D.Sc., Ph.D., F.I.C. Pp. xix + 496, $9\frac{3}{4} \times 6\frac{1}{4}$. Fifth Edition, Revised. (London: The Technical Press Ltd., 1935.) Price *28s.*

MOLYBDENUM STEELS. THEIR MANUFACTURE AND APPLICATION. Prepared for High Speed Steel Alloys Ltd. by Julius L. F. Vogel, M.I.E.E., M.I.M.M., and W. F. Rowden. Pp. 103, $9\frac{3}{4} \times 7\frac{1}{4}$. (Widnes: High Speed Steel Alloys Ltd., 1935.) Price 5*s*.

ANNUAIRE INTERNATIONAL DES MINERAIS ET METAUX. By Robert Pitaval and Raymond Sevin. Pp. 395, $9\frac{1}{2} \times 6\frac{1}{4}$. 1935 Edition. (Paris: Publications Minières et Metallurgiques S.A.R.L.). Price, France, 50 fr., abroad, 55 fr.

CONTENTS

VOL. XXXIII. NO. 4

REPORTS OF RECENT INVESTIGATIONS AT THE IMPERIAL INSTITUTE

Selected from the Reports made to the Dominion, Colonial and Indian Governments

NEW MATERIALS FOR PAPER AND BOARD MANUFACTURE

In the following pages an account is given of the results of investigation of a number of plants which have been examined in the laboratories of the Imperial Institute in recent years with a view to ascertaining their suitability for the manufacture of paper and boards.

Reeds (*Phragmites communis*) from Norfolk

The common reed (*Phragmites communis*) is widely distributed in the British Isles and other temperate regions, occurring in the marshy land bordering water-ways, lakes, etc. Amongst other places in this country it is particularly abundant in Norfolk, where it is estimated that there is an area of about 10,000 acres of marsh land yielding approximately 3 tons of reeds per acre. The collection of the reeds was at one time an important industry in Norfolk, large quantities having been used for thatching; but their employment for this purpose has declined with the growing use of other forms of roofing. If a new outlet could be found for the reeds their collection would do much to provide useful work for the agricultural labourers, particularly as the best time for cutting the material, January to April, coincides with the worst period of unemployment in the agricultural industries.

The recent introduction of the Danubian reed (a form of *Phragmites communis*) for the manufacture of paper suggested that the Norfolk reed might be employed for the same purpose. A Committee, consisting of representatives

of the Norfolk reed growers, the Technical Section of the Paper Makers' Association, the Development Commissioners, the Ministry of Agriculture and the Imperial Institute, was established in 1932 to investigate the position. Experiments were carried out, both on the laboratory scale and under manufacturing conditions. Preliminary investigations, made at the Imperial Institute, showed that the reeds can be readily converted into a pulp of fairly good quality, but the manufacturers' reports on the commercial prospects were much less promising. The paper-makers' trials indicated that the reeds would not be saleable as a substitute for esparto grass and would have to be used in competition with wood-pulp. Owing, however, to the comparatively low price of the latter and the small yield of pulp from the reeds (about 30 per cent.) when working on a commercial scale, it seemed unlikely that the price that would be offered for the reeds would cover the cost of collection and transport. As regards board manufacture the position was even less satisfactory. Firms who were consulted in the matter considered that the reeds could only be utilised as a substitute for the commonest grades of waste paper. The value of the waste paper plus the cost of treatment is, however, so low as to preclude entirely the possibility of the reeds competing with that material at the present time.

In view of these results the question of utilising Norfolk reeds for paper-making has been left in abeyance and there seems little likelihood of any developments taking place unless there is a considerable rise in the price of the raw materials normally employed. It was considered, however, that it would be worth while placing on record the results of the laboratory investigations conducted at the Imperial Institute, and the report is given below.

The material examined consisted of dry stems freed from sheathing leaves, cut to a length of about 3 ft. 9 in. and varying from $\frac{1}{10}$ to $\frac{1}{4}$ in. in diameter. The nodes occurred at intervals varying from 6 to 10 in., according to their position on the stem and the development of the latter. The reeds were generally pale yellow in colour.

A representative portion of the stems was chemically examined with the following results :

	Per cent.
Moisture	11·0
Ash	3·0
Cellulose (determined by chlorination method), expressed on material as received	50·0
Cellulose expressed on moisture-free material	56·2

The lengths and diameters of the ultimate fibres were found to be as follows :

	Length. mm.	Diameter. mm.
Maximum	3·0	0·0305
Minimum	0·8	0·0051
Average	1·6	0·0188

Paper.—A pulping trial was carried out on the reeds after cutting them up and crushing the nodes. The material was treated with caustic soda in a rotary digester and the following results were obtained :

Parts of caustic soda (NaOH) per 100 parts of		
Reeds		16
Solution		4
Conditions of digestion :		
Time	*hours*	4
Temperature	°C.	140
Parts of caustic soda consumed per 100 parts of reeds		10·2
Yield of moisture-free pulp :		
Expressed on reeds as received :		
Unbleached	*per cent.*	47·6
Bleached	,,	41·3
Expressed on moisture-free reeds :		
Unbleached	*per cent.*	53·5
Bleached	,,	46·4

The conditions of this digestion were just sufficient to yield a fairly well-cooked pulp, which furnished an opaque, fairly bulky paper, pale brown in colour and possessing good strength. A number of small fibrous specks, due to imperfectly reduced material from the nodes, were present in the paper.

The pulp bleached fairly readily and furnished a pale cream-coloured paper, of similar character and strength to the unbleached paper. The small specks in this case had to a great extent yielded to the bleaching treatment and subsequent beating.

These results show that under comparatively mild

conditions of digestion with caustic soda the reeds furnish a good yield of pulp of very satisfactory quality.

Boards.—Samples of board were made from the reeds under the experimental conditions shown in the following table. Trials Nos. 1 and 2 were made with caustic soda (NaOH), and trial No. 3 with sodium carbonate. In each case the trial was carried out under atmospheric pressure.

	Trial No. 1.	Trial No. 2.	Trial No. 3.
Parts of alkali used per 100 parts of Reeds	5(Na_2O) (equivalent to 6·45 of NaOH)	10(Na_2O) (equivalent to 12·9 of NaOH)	25(Na_2CO_3)
Solution	1	2	5
Conditions of digestion:			
Time . . . *hours*	2	2	3
Temperature . . $^\circ$ *C.*	100	100	100
Parts of alkali (Na_2O) consumed per 100 parts of reeds	2·8 (equivalent to 3·6 of NaOH)	3·1 (equivalent to 4·0 of NaOH)	—
Yield of moisture-free pulp:			
Expressed on reeds as received *per cent.*	57·2	56·3	69·2
Expressed on moisture-free reeds *per cent.*	64·3	63·3	77·8

With the very mild conditions of treatment in Trial 1 the reeds had been sufficiently softened to enable them to be fairly readily broken up in the beating machine, and after a comparatively short beating it was possible to form a strong board from the pulp. The board, however, contained a fairly large quantity of imperfectly reduced fibre.

In Trial 2, by using a solution containing alkali equivalent to 2 per cent. of sodium oxide (Na_2O), a product was obtained which could be more readily broken and beaten, and formed a fairly homogeneous board of good strength.

The treatment in Trial 3 with a 5 per cent. solution of sodium carbonate necessitated a longer cooking, and considerably more drastic beating, before the pulp was sufficiently broken up for use. The board then obtained was, however, generally of similar appearance and character to that produced in Trial 1.

Chique Reeds from Norfolk

The sample which is the subject of this report was examined in connection with the investigation of Norfolk reeds, referred to above. The material was described as "chique reed," and was stated to occur in the Norfolk Broads among the Norfolk reeds. A specimen of the reed was submitted by the Imperial Institute to the Director of the Royal Botanic Gardens, Kew, for botanical identification, and was considered to be most probably *Phalaris arundinacea* L., usually known as "reed grass."

The sample consisted of dried straw-like stems with sheathing leaves. The colour was generally pale yellowish-brown. The stems varied from $\frac{1}{10}$ to $\frac{1}{4}$ in. in diameter and were of irregular length. Nodes occurred at intervals of 5 to 12 in., according to their position on the stem and the state of development of the latter.

A representative portion of the material (including the leaves) was chemically examined with the following results, which are given in comparison with figures obtained at the Imperial Institute for Norfolk reeds (*Phragmites communis*).

	Present sample.	Norfolk reeds (*P. communis*).
	Per cent.	*Per cent.*
Moisture	9·6	11·0
Ash	3·5	3·0
Cellulose	49·2	50·0
Cellulose expressed on moisture-free material	54·4	56·2

The lengths and diameters of the ultimate fibres were as follows:

	Length.			Diameter.		
	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Present sample	0·7	3·3	2·0	0·0051	0·033	0·0135
P. communis	0·8	3·0	1·6	0·0051	0·0305	0·0188

Paper.—The present material, after being cut into short pieces, was treated with caustic soda in a rotary digester and the results, expressed on the material as received, are given below in comparison with the figures obtained for Norfolk reeds:

	Present sample.	Norfolk reeds (*P. communis*).
Parts of caustic soda per 100 parts of		
Reeds	16	16
Solution	4	4
Conditions of digestion :		
Time . . . *hours*	3	4
Temperature . . . ° *C.*	140	140
Parts of caustic soda consumed per 100 parts of reeds	9·7	10·2
Yield of moisture-free pulp :		
Unbleached . . . *per cent.*	42	47·6
Bleached . . . ,,	36	41·3
Yield of moisture-free pulp, expressed on moisture-free reeds :		
Unbleached . . . *per cent.*	46	53·5
Bleached . . . ,,	40	46·4

Under the conditions of this digestion the chique reeds yielded a well-cooked pulp, which, however, was of a very "wet" nature and furnished a hard, tough, rattly paper, of pale greyish-brown colour and possessing very good strength. A number of small imperfectly disintegrated fibrous particles were present, together with some specks of earthy matter from the original material.

The pulp bleached fairly readily to a pale cream colour, and then furnished paper of similar character and strength to that from the unbleached pulp. During the bleaching process the small pieces of unbroken fibre were disintegrated, but the specks of earthy matter remained unchanged and still marred the appearance of the sheet.

The foregoing results show that the chique reeds were more readily reduced to pulp than the *Phragmites communis* reeds from Norfolk previously examined, but furnished a rather lower yield of pulp. Although the pulp was comprised of fibre of good average length, and bleached no less readily than that from the *P. communis*, it was very "wet" and produced a hard, rattly paper, much less satisfactory than that from the *P. communis* reeds.

In view of the inferior quality of the paper obtained from these chique reeds, and the fact that some alterations would be required in the conditions of pulping and the subsequent operations of beating and working up into paper, it would seem undesirable to pulp chique and *Phragmites* reeds together for use in paper-making.

Boards.—Samples of board were made from the chique

reeds under the experimental conditions of treatment shown in the following table. For comparative purposes the results of experiments carried out on the Norfolk reeds under approximately similar conditions of treatment are also given. In both cases the digestion was carried out in an open vessel at atmospheric pressure.

—	Present sample.		Norfolk reeds (*P. communis*).	
	Trial 1.	Trial 2.	Trial 1.	Trial 2.
Parts of caustic soda used per 100 parts of				
Reeds	5·0	10·0	6·45	12·9
Solution	1·0	2·0	1·0	2·0
Conditions of digestion :				
Time . . . . *hours*	2	2	2	2
Temperature . . . . ° *C.*	100	100	100	100
Parts of caustic soda consumed per 100 parts of reeds	4·6	7·0	3·6	4·0
Yield of moisture-free pulp :				
Expressed on reeds as received *per cent.*	62	54	57·2	56·3
Expressed on moisture-free reeds *per cent.*	69	60	64·3	63·3

Under the mild conditions of Trial 1 the reeds were not sufficiently softened, and a rather heavy beating treatment was necessary to break down the material into a form suitable for manipulation. The board made in this trial was strong and fairly flexible, but contained a large proportion of unreduced fibre.

In Trial 2 the use of a stronger solution yielded a softer and well-cooked pulp, which broke down readily on beating and formed a homogeneous board of very good strength.

The pulp obtained under the conditions of these two trials was of a very " wet " nature, and difficulty was experienced in making the boards owing to the very slow rate at which the pulp lost water on draining.

The above results show that under similar conditions of treatment with alkali for board-making the chique reeds yielded about the same amount of pulp as that obtained from the *P. communis* reeds, and were capable of producing a board which was of good strength though not quite so strong and tough as that obtained from *P. communis*. The " wet " nature of the pulp might cause difficulties when working up on a board machine, but this difficulty

might perhaps be overcome by admixture with *P. communis* pulp. The board manufactured from the mixed materials would probably not be inferior to that obtained with *P. communis* alone.

GRASS (*HYPARRHENIA* SP.) FROM NORTHERN RHODESIA

The sample of grass which is the subject of this report was forwarded to the Imperial Institute by the Deputy Commissioner, H.M. Eastern African Dependencies Trade and Information Office, in August 1931.

The material had been received from the Government of Northern Rhodesia, and it was desired to ascertain its identity and its possibilities for paper-making.

The sample consisted of long tapering stems, generally yellow, and terminating in a long flowering head. They were 5 to 7½ in. in length, and up to ¼ in. thick at the base and about $\frac{1}{16}$ in. at the tips. The stems had rather hard nodes, from 8 to 12 in. apart, bearing sheathing leaves similar in colour to the stems.

The grass was submitted for identification to the Director of the Royal Botanic Gardens, Kew, who reported that it is *Hyparrhenia filipendula* Stapf (*Andropogon filipendulus* Hochst.).

A representative portion of the sample was submitted to chemical examination with the following results :

	Per cent.
Moisture	10·3
Ash	4·1
Cellulose	51·9
Cellulose expressed on the moisture-free material	57·9

The lengths and diameters of the ultimate fibres were found to be as follows :

	Length. mm.	Diameter. mm.
Maximum	4·2	0·0254
Minimum	0·5	0·0005
Average	2·1	0·0155

The chopped grass was submitted to treatment with caustic soda under conditions similar to those employed commercially for the production of pulp by the soda process, with the following results, which are expressed on the material as received :

		Trial A.	Trial B.
Parts of caustic soda employed per 100 parts of			
Grass		16	16
Solution		4	4
Conditions of digestion :			
Time	*hours*	4	5
Temperature	° *C.*	140	140
Caustic soda consumed per 100 parts of grass		6·2	0·2
Bleach[1] used per 100 parts of grass		15·0	15·0
Yield of moisture-free pulp :			
Unbleached	*per cent.*	43	41
Bleached	,,	41	40

[1] *Standard bleaching powder.*

The conditions of the experiment in Trial A were sufficient to produce a generally well-digested pulp, which furnished a fairly soft, opaque, very pale brown paper, of good strength. Numerous small fibrous specks, probably derived from the nodes, were, however, present in the paper. The pulp bleached fairly readily to a pale cream colour, and then furnished a strong paper of similar character to that yielded by the unbleached pulp. The small specks present in the unbleached paper had not been entirely eliminated by the bleaching treatment.

The increased time of digestion in Trial B did not appear to have effected any appreciable improvement in the case of the unbleached pulp, which furnished paper similar to that produced in Trial A, although the small fibrous specks were not quite so numerous as before. The pulp bleached fairly readily to a very pale cream colour, and then furnished a strong, opaque, rather bulky paper of good quality. In this case the small specks had practically all yielded to the bleaching treatment.

The results of examination show that with only a moderate consumption of soda this *Hyparrhenia filipendula* grass furnished a fairly good yield of pulp. The pulp, however, required a rather large amount of bleaching powder to reduce the colour to a satisfactory whiteness. The pulp was composed of fibres of good length, which felted well and produced strong paper. Pulp made from the grass should be very suitable for mixing with short-fibred pulps from African woods.

In the case of the present sample it was found impracticable to remove the flowering heads of the grass without sacrificing a large proportion of the material.

There is, however, little doubt that the discarding of this part of the grass would result in an appreciable increase in the yield of pulp, which moreover would bleach more readily.

Although this grass is suitable for the manufacture of paper pulp on a commercial scale, it could not be profitably exported in the raw state for this purpose, but would have to be converted in Rhodesia into "half-stuff" for export.

Typha latifolia from Australia

Typha latifolia, the greater bulrush, is found growing in the shallow margins of standing water in most parts of the globe. A sample of the plant from Australia was forwarded by the Secretary of the Council for Scientific and Industrial Research in June 1934. It was desired to ascertain the possibility of employing the plant for industrial purposes.

The plant, which is known in Australia as "Cumbungi," grows extensively in irrigated areas of New South Wales and Victoria, and is reported to have spread so rapidly in recent years as to be a serious menace to the growth of rice and other cultivated crops.

The sample consisted of long narrow leaves, cut into lengths of 18 in. and tied into bundles. The leaves varied in colour from pale brown at the base to yellowish-green and green towards the tips. They were brittle, and although of a fibrous nature contained a large proportion of pithy matter. The greater part of the sample consisted of leaves varying from $\frac{1}{4}$ to $\frac{1}{2}$ in. in width and from $\frac{1}{8}$ to $\frac{1}{4}$ in. in thickness, but at the base they were larger, ranging up to $1\frac{1}{2}$ in. in width and $\frac{1}{2}$ in. in thickness.

Attempts have been made from time to time to prepare fibre from the leaves. For example, in 1927, a sample of fibre prepared from a species of *Typha* was received at the Imperial Institute from Egypt. The fibre was fine, but possessed little strength, and material of similar quality would only find a limited market. It is also stated that a very soft and fine fibre has been prepared from *Typha* leaves experimentally in India, but that it is of little value in comparison with many other fibres which can be prepared from native weeds.

A trial was made in the preparation of fibre from the present sample of leaves by the following process. The

leaves were split and, after being combed to remove as much pith as possible, were allowed to soak in dilute (1 per cent.) sodium carbonate solution at the ordinary temperature. After some days it was possible to remove most of the remaining pithy matter by a light scraping and washing treatment.

The fibre finally obtained was rather coarse, weak and brittle, and it was not found possible to extract fine strands of any considerable length. It seems possible that by working with fresh green leaves a somewhat better material might be obtainable, but it is not likely to be worth preparing except possibly for local use.

With a view to ascertaining the utility of the material as a source of paper-pulp, the following experiments were carried out.

A representative portion of the sample was submitted to chemical examination, with the results shown below:

	Per cent.
Moisture	16·1
Ash	7·4
Cellulose	36·1
Cellulose expressed on moisture-free material	43·0

The ultimate fibres possessed the following dimensions:

	Length. *mm.*	Diameter. *mm.*
Maximum	4·6	0·0254
Minimum	0·8	0·0051
Average	2·1	0·0112

Paper.—The leaves, after being cut into small pieces, were submitted to treatment with caustic soda under conditions similar to those employed commercially for the production of paper-pulp by the soda process. The results obtained were as follows:

Parts of caustic soda used per 100 parts of		
Leaves		16
Solution		3
Conditions of digestion:		
Time	*hours*	3
Temperature	° *C.*	140
Parts of caustic soda consumed per 100 parts of leaves		8·5
Yield of moisture-free pulp:		
Expressed on leaves as received:		
Unbleached	*per cent.*	30·4
Bleached	,,	22·1
Expressed on moisture-free leaves:		
Unbleached	*per cent.*	36·2
Bleached	,,	26·3

Under these conditions of digestion a well-cooked pulp was obtained which broke down fairly readily on beating. The pulp possessed little "wet" strength but it furnished a pale brown, tough, somewhat rattly opaque paper, of good strength. The paper showed a little shrinkage on drying.

The pulp did not bleach readily, and a strong bleaching treatment was found necessary in order to reduce the colour to a pale cream. The paper furnished by the bleached pulp thus obtained was of similar character and strength to that from the unbleached pulp, but its appearance was spoilt by the presence of numerous small specks due to iron.[1]

The foregoing results show that these *Typha* leaves are capable of producing strong paper of fair quality. The yields of pulp obtained were, however, very low, owing to the quantity of non-fibrous matter present, which has practically no paper-making value.

Boards.—Owing to the comparative ease with which the leaves could be pulped, an experiment was carried out to ascertain their suitability for board-making. For this purpose the naturally occurring pithy matter would assist in cementing together the fibre in the boards. The following results were obtained:

Parts of sodium carbonate per 100 parts of		
Leaves		25
Solution		5
Conditions of treatment[1]:		
Time	*hours*	3
Temperature	°*C.*	100
Yield of moisture-free unbleached pulp:		
Expressed on leaves as received	*per cent.*	55·3
Expressed on moisture-free leaves	"	65·9

[1] *At atmospheric pressure in open vessel.*

Under these very mild conditions of treatment the leaves were sufficiently softened to enable them to be readily broken down in the beating machine. The pulp obtained was of "wet" character, but furnished a fairly tough, flexible board, which would prove suitable for a variety of purposes.

[1] Qualitative tests showed that a fair quantity of iron was present in the leaves, in water-soluble form. The presence of the specks in both types of paper may possibly be accounted for by the fact that the soluble iron had been hydrated by the caustic soda during digestion and occluded by the pulp.

From the results obtained in the paper-making trial it will be seen that the present *Typha* leaves do not represent a promising source of paper-pulp, as although the material yields readily to treatment, the yields of pulp are very low owing to the large proportion of pith present. The unbleached paper might be marketable as a cheap wrapping paper, but the manufacture of bleached papers from the leaves would probably be unremunerative. Furthermore, the presence of iron in the paper would prove to be an objectionable factor in some classes of manufacture.

It might prove possible to remove a large proportion of the pith and iron from the leaves by a preliminary crushing and washing treatment. If this operation could be carried out economically at the source of supply the treated material would furnish a larger yield of better quality pulp, and by the adoption of this preliminary treatment a saving in freightage charges to the place of manufacture would be effected.

It seems likely that the leaves might be of greater value for the manufacture of strawboards and boxboards, as the present trials show that a high yield of pulp of suitable quality for board-making could be obtained under mild conditions of treatment. Judging from the hand-made specimens of board prepared at the Imperial Institute, pulp of this nature could under suitable conditions be utilised for manufacturing boards for various purposes, but large-scale trials in a works would be necessary to decide the question.

Gelam Wood (*Melaleuca Leucodendron*) from Malaya

Some logs of "gelam" (*Melaleuca Leucodendron* Linn.) were forwarded to the Imperial Institute by the Forest Department, Kedah, in September 1932, in order to ascertain the value of the wood as a source of paper-pulp.

M. Leucodendron, the cajeput or paper bark tree (natural order Myrtaceæ), has a wide distribution in the East Indies, extending from Tenasserim to the Moluccas. It is a gregarious species and grows in wet, low-lying spots, often inundated in the rainy season. The chief uses of the timber are as firewood, for which purpose some of the gelam forests in Malaya are reserved, and as posts, piles,

etc., its durability in contact with moist ground rendering it specially suited to the latter purposes.

There is a large area of gelam in Kedah, and a great part, lying between the railway and the sea, is served by irrigation canals, so that extraction of the timber would present no difficulty. There is a proposal to reserve an extensive area of these forests, and as the tree is easy to grow there should be no difficulty as regards supplies of the wood, should it prove suitable for paper-making.

The material received at the Imperial Institute consisted of four small logs, 40 in. long and 8½ to 9 in. in diameter. Two of the pieces were partly covered with a rather thin, fibrous bark. The wood was hard, close-grained and of pale pinkish-brown colour.

The wood was submitted to chemical examination with the following results :

	Per cent.
Moisture	14·4
Ash	0·6
Cellulose	40·3
Cellulose expressed on the moisture-free wood	47·1

On microscopical examination the lengths and diameters of the ultimate fibres were found to be as follows :

	Length. *mm.*	Diameter. *mm.*
Maximum	1·6	0·0254
Minimum	0·3	0·0076
Average	1·1	0·0163

The chipped wood was submitted to treatment with caustic soda under conditions similar to those employed commercially for the production of paper-pulp by the soda process. The results obtained, expressed on the wood as received, were as follows :

		Trial A.	Trial B.
Parts of caustic soda per 100 parts of			
Wood		20	20
Solution		4	4
Conditions of digestion :			
Time	*hours*	5	5
Temperature	° *C.*	150	160
Parts of caustic soda consumed per 100 parts of wood		12·7	12·9
Yield of moisture-free pulp :			
Unbleached	*per cent.*	43	37
Bleached	,,	36	34
Yield of moisture-free pulp expressed on the moisture-free wood :			
Unbleached	*per cent.*	50·2	43·2
Bleached	,,	42·1	39·7

The conditions of digestion in Trial A were not sufficiently severe to produce a well-reduced pulp, and the resulting product could only be broken down after long and drastic beating. The pulp furnished an opaque, somewhat soft, bulky paper, dark yellowish-brown in colour and possessing fairly good strength. The paper contained numerous partially disintegrated specks, which mostly appeared on the under-side of the sheet. The pulp did not bleach readily, and the use of a very strong bleaching solution was necessary. The pulp then furnished a rather dark cream-coloured paper, similar in character and strength to the unbleached paper. The fibrous specks had not yielded to the bleaching treatment to any great extent.

The increased temperature of digestion in Trial B was sufficient to yield a well-reduced pulp which furnished a pale brown, opaque, bulky paper, similar in character to that described above and containing a small quantity of imperfectly disintegrated particles. The pulp was still rather resistant to the action of the bleach and a fairly strong solution was found necessary to produce a very pale cream-coloured paper. The paper was of similar character and strength to the unbleached paper except that only a few small specks of unreduced fibre were left, the majority having been broken down by the bleaching treatment.

The results of examination show that this sample of gelam wood furnished a short-fibred pulp composed of fibres of similar length to those of the broad-leaved woods, such as poplar, which are employed for the manufacture of paper-pulp, usually by the soda process. The yield of unbleached pulp in Trial B (viz. 37 per cent.) was, however, lower than that obtained at the Imperial Institute from a sample of poplar wood (47 per cent.) ; moreover, the latter wood, being softer, required less drastic conditions for the digestion and the pulp was much easier to bleach.

The pulp from the gelam wood felted well and produced fairly strong paper, rather similar in character to that obtained from poplar or aspen pulp, and it could be utilised as a substitute for the latter in the manufacture of book and printing papers. In view, however, of the comparatively severe treatment required for pulping, the rather

low yield of bleached pulp and the fact that the pulp did not bleach readily, it is doubtful whether gelam wood could be remuneratively employed as a paper-making material. In any case it would not be profitable to export the wood itself and it would therefore be necessary for the pulp to be manufactured in Malaya. This would entail a considerable outlay for the erection and equipment of a pulp-mill and the importation of the necessary chemicals.

In view of the cost of shipping the pulp to the United Kingdom, where it would have to compete with the abundant supplies of wood-pulp already cheaply available, it seems probable that an outlet for the pulp would have to be found in the East.

Mangrove Wood from Gambia

A supply of mangrove wood (*Rhizophora racemosa*) was forwarded to the Imperial Institute by the Acting Colonial Secretary, Gambia, in February 1933, in order to ascertain the value of the wood for the production of paper-pulp.

The material had been graded into three sizes, as follows:

(1) "*Thick Base.*"—Stems of irregular shape, varying from 2 to 4½ in. in diameter and approximately 3½ ft. in length. The wood, which was exceedingly hard and tough, was generally pale brown and towards the base contained a very hard, dark brown core. The stems were covered with a rather soft, dark brown, closely adhering bark.

(2) "*Top.*"—Stems varying from 1 to 2 in. in diameter and of similar length to the above. The wood and bark were slightly paler than in the "thick base" sample, but otherwise were of similar character.

(3) "*Thin Branch.*"—Thin branches, from which the smaller twigs had been trimmed, varying from ¼ to ¾ in. in diameter and approximately 3½ ft. in length. The wood was exceptionally tough and splintery and the bark was rather harder than that at the base of the "thick" sample.

Representative portions of Samples Nos. 1 and 3, including the bark, which it was not practicable to remove, were reduced to chips and allowed to dry in the air. They were then chemically examined with the following results:

	No. 1. Thick Base. *Per cent.*	No. 3. Thin Branch. *Per cent.*
Moisture	17·5	14·6
Ash	4·5	5·7
Cellulose	39·15	39·3
Cellulose expressed on moisture-free wood	47·5	46·0

The lengths and diameters of the ultimate fibres were as follows :

	Length.			Diameter.		
	Maximum.	Minimum.	Average.	Maximum.	Minimum.	Average.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Thick Base	1·2	0·5	0·9	0·0254	0·0102	0·0155
Thin Branch	1·2	0·5	0·8	0·0254	0·0102	0·0147

The two samples were submitted to treatment with caustic soda under conditions similar to those employed commercially for the production of paper-pulp, with the following results, which are expressed on the air-dried wood:

		Thick Base.	Thin Branch.
Parts of caustic soda employed per 100 parts of			
Wood		20	20
Solution		4	4
Conditions of digestion :			
Time	*hours*	5	5
Temperature	° *C.*	160	160
Parts of caustic soda consumed per 100 parts of wood		13·2	14·0
Yield of moisture-free pulp :			
Unbleached	*per cent.*	28·2	31·6
Bleached	,,	22·2	27·7
Yield of moisture-free pulp, expressed on moisture-free wood :			
Unbleached	*per cent.*	34·2	37·0
Bleached	,,	26·9	32·4

Under the conditions of these trials the " thick base " sample was sufficiently digested to yield a well-reduced, homogeneous pulp, which furnished a fairly soft, bulky, opaque, greyish-brown paper of fair strength. Occasional dark-coloured specks were present in the paper. The pulp did not bleach readily, and a strong bleaching solution was found necessary to reduce the colour to a pale cream. The dark-coloured specks were rendered inconspicuous by the treatment. The resulting paper was slightly stronger than the unbleached paper, but otherwise of similar character.

The " thin branch " sample also furnished a well reduced pulp which yielded a rather soft, bulky, opaque

paper of fair strength and of somewhat paler colour than that obtained from the "thick base" sample. Some small, hard, dark-coloured specks were present in the paper, the number being larger than in the case of the pulp from the "thick base" sample. The pulp did not bleach readily, and a strong bleaching solution was again found to be necessary. The pulp thus obtained was pale cream in colour, but many of the small, hard particles were still visible as pale brown specks. The paper produced from the bleached pulp was of similar character to the unbleached paper but slightly stronger.

The foregoing results show that there is no appreciable difference between the paper-making qualities of the "thick base" and "thin branch" samples. Both samples (including the bark), when digested under similar conditions to those adopted for most woods used in commercial practice, broke down fairly readily, but they furnished only comparatively low yields of pulp, and the consumption of soda was rather high. The pulps bleached with difficulty, and were composed of ultimate fibres of a smaller average length than those of commercial short-fibred pulps. The papers obtained were, however, of fairly good strength. The "thin branch" sample, although furnishing a rather higher yield of pulp than the "thick base," did not break down quite so readily during digestion, and the paper obtained, though somewhat paler in colour, contained a number of undesirable specks. This was due apparently to the presence, at the places where branching occurred, of hard knots which were not readily disintegrated.

In view of the similarity in the results obtained with the "thick base" and "thin branch" samples it was not considered necessary to examine the sample labelled "top."

The investigation showed that the Gambia mangrove wood represented by the present samples furnishes a short-fibred pulp which is difficult to bleach. It might possibly be utilised for the production of cheap grades of writing and printing papers, but would be an unsatisfactory substitute for the short-fibred paper-making woods now used commercially. The strength of the paper from the unbleached pulp is probably insufficient to permit of the pulp being used for the manufacture of wrapping papers.

In view of the low yield of pulp, the difficulty of bleaching and the inferior character of the paper produced, it seems unlikely that this mangrove wood from the Gambia would be of commercial interest for the production of paper pulp.

Sisal Refuse from Tanganyika

In order to investigate the possibility of utilising the refuse produced in the preparation of Sisal fibre for the manufacture of fibre boards, two samples of the material were forwarded to the Imperial Institute by the Director of the East African Agricultural Research Station, Amani, in September 1932.

The samples received were as follows :

(1) *Dry Refuse from the Dump.*—This consisted of a mixture of approximately equal parts of fibre and non-fibrous leaf pulp, the latter being partly loose and partly adherent to the fibre. The length of the fibres ranged from 8 to 24 in.

(2) *Wet Refuse from the Mill (Autoclaved).*—This sample had fermented and possessed a very strong and objectionable odour of butyric acid. As in sample 1, about 50 per cent. of the dry material was fibre.

The results of examination of the samples were as follows :

(1) *Dry Refuse from the Dump*

This material gave the following figures on chemical examination :

	Per cent.
Moisture	12·7
Ash	9·6
Cellulose [1]	49·75
Cellulose expressed on the moisture-free refuse	57·0

[1] *Determined by the chlorination method.*

A portion of the refuse was taken and the fibre in it was cut into pieces approximately 4 in. long ; the material was then submitted to treatment with caustic soda solution under conditions similar to those employed commercially for the production of pulp. The following results were obtained, and are expressed on the refuse as received :

		Trial A.	Trial B.
Parts of caustic soda per 100 parts of			
Refuse		10	12
Solution		2	2
Conditions of digestion:			
Time	*hours*	2	2
Temperature	°*C.*	120	130
Parts of caustic soda consumed per 100 parts of refuse		9·1	10·6
Yield of moisture-free pulp	*per cent.*	53·5	44·8

The conditions of Trial A were not severe enough to disintegrate the material much, but softened the fibre sufficiently to enable it to be treated in the small laboratory beater. The pulp obtained was of an exceptionally "wet" nature owing to the presence of the non-fibrous material, and was found difficult to work. Boards were made on a hand-mould and dried in a steam-heated press, but the finished board, though pliable and possessing good strength, was of unattractive appearance, being blotched and spotted with numerous fragments of incompletely disintegrated epidermal tissue.

In Trial B, rather more severe conditions of digestion were employed in order to break down more of the non-fibrous material. The pulp thus obtained was softer than that produced in Trial A, and could be reduced rather more readily in the beater. The boards made from it, however, did not differ greatly in appearance from those of Trial A.

Owing to the very "wet" nature of the pulp obtained in these digestions and the resulting difficulty in working, a portion of the dry refuse was shaken and rubbed through a sieve in order to remove as much of the "pithy" matter as possible. The portion lost in this operation amounted to about 38 per cent. by weight of the original refuse as received. The resulting material was treated under similar conditions to those of Trial B, with the following results:

		Trial C.
Parts of caustic soda per 100 parts of		
Cleaned refuse		12
Solution		2
Conditions of digestion:		
Time	*hours*	2
Temperature	°*C.*	130
Parts of caustic soda consumed per 100 parts of cleaned refuse		10·8
Yield of moisture-free pulp expressed on cleaned refuse	*per cent.*	54·6
Yield of moisture-free pulp expressed on original refuse before cleaning	*per cent.*	33·7

The pulp obtained in this trial required a similar beating treatment to that employed in Trial B. It was still of a somewhat " wet " character, and some difficulty was again experienced in forming the boards. The finished board was rather paler in colour and somewhat freer from epidermal fragments than in the previous trials, but was otherwise of similar character and strength.

In addition to the foregoing pulping trials by the ordinary method, a further experiment was carried out on the sample of refuse from the dump, in which it was subjected to much milder conditions of treatment. The digestion was carried out with a dilute sodium carbonate solution in an open vessel, with the idea of softening the non-fibrous matter but not affecting the natural rigidity of the short lengths of fibre employed and of thus obtaining a board which would contain practically unaltered fibre cemented together with pithy material. For this purpose, a quantity of the dry refuse was cut into lengths of from ½ to 1 in., and boiled with sodium carbonate solution under the following conditions :

		Trial D.
Parts of anhydrous sodium carbonate per 100 parts of		
Refuse		15
Solution		2
Conditions of digestion :		
Time	*hours*	3
Temperature (in open vessel)	° *C.*	100
Yield of moisture-free pulp :		
Expressed on material as received	*per cent.*	66·6
Expressed on moisture-free material	,,	75·5

Both the fibre and the epidermal tissue after this treatment were practically unaltered, but the pithy portion of the non-fibrous material had softened and swollen. Subsequent treatment in the beater, with the roll raised, was sufficient to break up most of the pithy matter and distribute it evenly throughout the mass. The pulp then obtained was rather " wet," and furnished a board of good bulk, which, however, was rather soft and tended to break down into layers.

(2) *Wet Refuse from the Mill*

The material, after being air-dried, was submitted to chemical examination with the following results :

	Per cent.
Moisture	8·6
Ash	8·5
Cellulose [1]	48·1
Cellulose expressed on the moisture-free refuse	52·6

[1] *Determined by the chlorination method.*

In the course of drying the refuse in the air the greater part of the non-fibrous matter had become loosened from the fibre, and most of that still adhering was detached by a gentle shaking and rubbing treatment. The amount of material removed during drying and in this subsequent treatment amounted to about half the weight of the air-dried refuse.

A pulping trial was carried out on the remaining fibrous material under the conditions shown below, which are the same as those employed in the foregoing Trials B and C with the sample of refuse from the dump:

	Trial E.
Parts of caustic soda per 100 parts of	
Fibrous material	12
Solution	2
Conditions of digestion:	
Time . *hours*	2
Temperature . *°C.*	130
Parts of caustic soda consumed per 100 parts of the fibrous material	11·5
Yield of moisture-free pulp expressed on the fibrous material *per cent.*	56·7
Yield of moisture-free pulp expressed on original (air-dried) refuse *per cent.*	28·4

The conditions of treatment were not sufficiently drastic to yield a well-softened pulp. The pulp was rather difficult to break down and yielded a product of greenish-brown colour, which furnished a board of rather harder character than that obtained from the sample of refuse from the dump.

General Conclusions

The present experiments have shown that the Sisal refuse is not a very satisfactory material for the manufacture of boards, owing to the undesirable effect of the large proportion of non-fibrous matter present. The pithy portion of the latter renders the pulp very "wet" and difficult to manipulate, and also produces shrinkage and objectionable warping and buckling in the finished boards, the appearance and quality of which are decidedly unattrac-

tive. The yields of pulp obtained, considering the comparatively mild conditions employed in the various digestions, were, moreover, rather low.

Jarrah Bark from Western Australia

Jarrah (*Eucalyptus marginata*) is one of the most important of Western Australian timbers. The question of utilising the large quantities of bark which accumulate at the saw-mills has been engaging the attention of the Forest Department in recent years, and in November 1932 the Conservator of Forests forwarded samples of the bark to the Imperial Institute in order to ascertain whether the material could be employed for the manufacture of pulp for board-making. It has been estimated that on a basis of a normal cut of 500,000 loads of Jarrah timber per annum it would be possible to obtain 37,500 loads of the bark annually.

Samples of the inner bark of the tree and of the complete bark were received. They were as follows :

No. 1. *Inner Bark.*—This consisted of four pieces, each measuring approximately 4 × ¼ × 21 in. The bark, which was pale reddish-brown, was strong and very fibrous and possessed a slightly interlaced structure.

No. 2. *Complete Bark.*—This consisted of three pieces, each measuring 9 × 1 × 36 in. The outer bark, which was approximately ¾ in. in thickness, was composed of short, very brittle, rather papery fibre, dark reddish-brown in colour. The inner bark was similar to the foregoing sample.

Representative portions of the two samples were submitted to chemical examination with the following results, which are expressed on the materials as received :

	Inner Bark. *Per cent.*	Complete Bark *Per cent.*
Moisture	10·0	12·3
Ash	4·6	3·3
Cellulose	38·8	39·9
Cellulose expressed on moisture-free material	43·1	45·5

In order to ascertain the suitability of the materials for the manufacture of boards, the following pulping trials were carried out.

No. 1. *Inner Bark.*—In this case the material was treated with caustic soda, with the following results :

		Trial A.	Trial B.
Parts of caustic soda used per 100 parts of			
Bark		10	15
Solution		2	3
Conditions of digestion :			
Time	*hours*	$1\frac{1}{2}$	2
Temperature	° *C.*	100 [1]	120 [2]
Parts of caustic soda consumed per 100 parts of bark		9	15
Yield of moisture-free pulp :			
On bark as received	*per cent.*	47·75	39·1
On moisture-free bark	,,	53·1	43·4

[1] *Open vessel.*
[2] *Under pressure in rotary digester.*

The conditions of treatment in Trial A hardly did more than effect the partial separation of the fibre, and the subsequent beating operation did little to break down the material to a workable condition. The pulp finally obtained was long-fibred, and was of an exceptionally "free" nature, so that the formation of a board was difficult. The pale reddish-brown board produced was fairly tough and fibrous, but broke on bending and tended to separate into layers.

Under the more drastic conditions of Trial B the bark did not break down so readily as was expected. The pulp obtained worked rather better in the beater, but the "freeness" of the fibre again rendered board-formation difficult as in the case of Trial A. The board obtained was rather closer and had felted better than that produced in the previous experiment, but it was otherwise of similar strength and possessed the same tendency to break on bending.

These two experiments were sufficient to show that even with a high consumption of soda the fibre structure of the inner bark was very resistant to the alkali, and that the pulp obtained was of too "free" a nature to be suitable by itself for the production of boards.

No. 2. *Complete Bark.*—In view of the high consumption of alkali in the foregoing trials with the inner bark, and the difficulty experienced in working up the pulp produced, it was decided to make a trial on somewhat different lines with the complete bark. It was accordingly

treated with water alone under pressure at high temperatures. The conditions of treatment and the yields of pulp obtained are given in the following table :

		Trial C.	Trial D.
Conditions of digestion :			
Time		$1\frac{1}{2}$	$1\frac{1}{2}$
Temperature	°C.	170	145
Gauge pressure	*lb.*	100	50
Yield of moisture-free pulp :			
On bark as received	*per cent.*	42·3	52·8
On moisture-free bark	,,	48·2	60·2

Under the conditions of Trial C the fibre structure of the bark was partially destroyed, and the material appeared to have suffered from slight charring. The fibre broke down readily in the beater and formed a dark reddish-brown board, which was well felted but soft and weak.

Under the rather milder conditions of temperature and pressure in Trial D the resulting material was just sufficiently softened to enable it to be fairly readily broken down in the beater. The pulp, whilst rather difficult to work, furnished a well closed, compact, rather soft board, of a slightly lighter tint than that produced in Trial C.

The pulp obtained from the complete bark, like that from the inner bark, possessed a tendency to work " free," and it was obvious that some binding material would be necessary to stiffen the board. An experiment was therefore carried out in adding to the pulp, prepared under the conditions of Trial D, a short-fibred pulp containing non-fibrous thin-walled elements which would serve as a cementing material. For this purpose some wheat-straw pulp was prepared under the following conditions :

Parts of caustic soda used per 100 parts of		
Straw		10
Solution		2
Conditions of digestion :		
Time	*hours*	$1\frac{1}{2}$
Temperature	°C.	100[1]
Parts of caustic soda consumed per 100 parts of straw		4·2
Yield of moisture-free pulp	*per cent.*	54·6

[1] *Open vessel.*

Equal parts of the bark pulp from Experiment D and the straw pulp prepared as above were beaten together and subsequently formed into board. The addition of this

equal quantity of straw pulp was sufficient to counteract the " freeness " of the bark pulp, and on drying an exceptionally hard board was obtained which did not warp or show any tendency to break down into layers on bending.

The investigation showed that Jarrah bark is capable of furnishing a fairly good yield of coarse-fibred pulp of very satisfactory strength, which could be utilised in the manufacture of boards.

The experiments indicate that caustic alkali, when used in the concentrations normally employed in pulping operations, is all consumed without greatly assisting in the separation of the fibre, but that the bark can be readily disintegrated with water at a high temperature under pressure without the addition of chemicals.

The useful fibre is confined to the inner bark, but the separation of the latter for pulping is not likely to offer any practical advantage or to prove an economical undertaking, as the friable outer bark would be largely eliminated during the preparation and beating of the pulp.

In all the experiments the prepared pulp was of a " free " nature and required the addition of a suitable short-fibred pulp to act as a cementing material, in order to obtain strong hard boards of satisfactory quality. In the experiments made at the Imperial Institute wheat-straw pulp was used for this purpose, but any similar material, such as pulp prepared from maize stalks or sugar-cane bagasse, would serve equally well.

COTTON BARK AS A SOURCE OF RAYON PULP

A sample of the bark of cotton stalks was forwarded to the Imperial Institute by the Director of Agriculture, Tanganyika, in February 1933, in order to ascertain its possible value for the preparation of pulp for the manufacture of rayon. The possibility of utilising the whole stalks for paper-making was investigated some years ago at the Imperial Institute and a report on a sample received from India will be found in this BULLETIN (1921, **19**, 15). The stalks produced a pulp of fair quality, but the yield was rather low.

The sample from Tanganyika consisted of strips of somewhat tough, fibrous bark which varied from about $1\frac{1}{2}$ to 3 ft. in length and from $\frac{1}{8}$ to $\frac{1}{2}$ in. in width.

A representative portion of the material was chemically examined with the following results, which are expressed on the material as received :

	Per cent.
Moisture	11·8
Ash	5·9
Cellulose	30·45
Cellulose expressed on the moisture-free bark	34·5

The ultimate fibres had the following dimensions :

	Length. mm.	Diameter. mm.
Maximum	4·2	0·0279
Minimum	0·7	0·0102
Average	1·9	0·0201

The bark was cut into small pieces and submitted to treatment with caustic soda under conditions similar to those employed for the production of paper pulp by the soda process. The following results, expressed on the bark as received, were obtained :

Parts of caustic soda used per 100 parts of		
Bark		16
Solution		4
Conditions of digestion :		
Time	*hours*	3
Temperature	° *C.*	150
Parts of caustic soda consumed per 100 parts of bark		14·6
Yield of moisture-free pulp :		
Unbleached	*per cent.*	31·3
Bleached	,,	18·1
Yield of moisture-free pulp, expressed on moisture-free bark :		
Unbleached	*per cent.*	35·5
Bleached	,,	20·5

The conditions of this digestion were barely drastic enough to yield a well-reduced pulp. The pulp obtained was strong and very fibrous, and necessitated a strong beating treatment to break it down.

The pulp did not bleach readily, and a strong bleaching solution was necessary to reduce the colour to a pale cream.

The bleached pulp obtained in the above trial was

examined as to its suitability for use in rayon manufacture. On analysis it gave the following figures, which are shown in comparison with those recorded for a commercial bleached sulphite wood-pulp suitable for the manufacture of rayon :

		Present sample of cotton-bark pulp.	Bleached sulphite wood-pulp.
		Per cent.	*Per cent.*
Moisture		9·4	10·0
Expressed on the moisture-free pulp	Ash	1·4	0·1–0·4
	α-Cellulose	81·6	86–89

The above analysis shows that the bleached pulp prepared from the cotton bark contained more ash constituents and less α-cellulose than commercial bleached sulphite wood-pulp of good quality, and that it was not of sufficient purity to be suitable for the manufacture of rayon. A pulp to be used for this purpose should contain at least 85 per cent. of α-cellulose and give not more than 0·3 per cent. of ash. A special quality of wood pulp which is now being supplied to manufacturers contains about 89 per cent. of α-cellulose.

A further trial was carried out with the object of ascertaining whether a pulp containing a higher percentage of α-cellulose could be obtained by modifying the conditions of digestion, and the following results were obtained (expressed on the material as received) :

Parts of caustic soda used per 100 parts of		
Bark		20
Solution		4
Conditions of digestion :		
Time	*hours*	4
Temperature	*° C.*	155
Parts of caustic soda consumed per 100 parts of bark		18·4
Yield of bleached moisture-free pulp	*per cent.*	16·0 [1]

[1] *Equivalent to 18·1 per cent. expressed on the moisture-free bark.*

The pulp obtained in this trial was found to contain only 78·1 per cent. of α-cellulose (expressed on the moisture-free pulp). It thus appears that the more severe treatment employed caused a reduction in the percentage of pulp obtained but did not improve the percentage of α-cellulose present, which, it will be observed, was lower than that in the pulp produced in the previous trial. It seems probable that this result may have been due to the degradation of

a part of the cellulose by the somewhat drastic conditions employed.

It is possible that by carrying out a number of trials, conditions of treatment could be found under which the cotton bark would yield a bleached pulp possessing the standard of quality required for rayon manufacture, but it is evident that the yield would be too low for economical working. Even if the pulp obtained in the first trial should have proved of sufficient purity for the purpose in view, the yield would be too small to be profitable, as over 5 tons of the bark would be required for the production of 1 ton of pulp, whereas spruce wood yields as much as 45 to 50 per cent. of bleached pulp suitable for rayon manufacture.

ÆOLANTHUS GAMWELLIÆ OIL FROM NORTHERN RHODESIA

In 1930 a sample of oil distilled from the flowers of a species of *Æolanthus* was forwarded to the Imperial Institute by Miss A. Hope Gamwell, of Abercorn, Northern Rhodesia. Preliminary investigations indicated that the oil might be of interest in perfumery and arrangements were accordingly made for further samples to be furnished for examination. In all, five samples, representing oil distilled from flowers gathered during the seasons 1930 to 1934, have been received.

The plant in question, which is known locally as "Nindi," is said to be common in rocky situations in the Abercorn District; it attains a height of about 6 ft., is bushy in habit and produces mauve flowers of pleasant aroma. Examination of herbarium specimens of the plant proved it to be a new species, which has been described by Mr. G. Taylor, of the Botanical Department, British Museum (Natural History), under the name *Æolanthus Gamwelliæ*, after its discoverer (*Journ. of Bot.*, April 1932, p. 105).

From the information received from Miss Gamwell it would appear that the fresh flowers yielded about 1·0 to 1·7 per cent. of oil.

The oil possessed a pleasant odour somewhat resembling

that of geranium oil, and on examination the five samples furnished the following range of constants :

Specific gravity at 15·5/15·5° C.	0·8901 to 0·8915
Optical rotation α_D	− 0·43° to − 0·66°
Refractive index $n_D 20°$ C.	1·4730 to 1·4750
Acid value	0·9 to 3·9
[1] Ester value	27·0 to 39·8
Equivalent to esters as $C_{10}H_{17}O.CO_2.CH_3$ in the original oil *per cent.*	9·1 to 13·3
[1] Ester value after acetylation	251·0 to 270·4
Equivalent to "total alcohols" $C_{10}H_{18}O$ in the original oil *per cent.*	79·5 to 90·0
Aldehydes and/or ketones (by bisulphite method) *per cent.*	2 to 7
Solubility in 70 per cent. alcohol at 15·5° C.	Soluble in 1 to 1·6 vols.

[1] *Determined on the aldehyde-free oil.*

Chemical examination of the oil showed that it consisted principally of geraniol. An estimation of citronellol by the formylation method in a portion of the oil previously freed from aldehydes indicated the presence of about 5 per cent. of this alcohol in the original oil. The aldehydic portion of the oil appeared to contain citral, but the identity of this compound was not definitely established.

The examination indicated that the oil had the following composition :

	Per cent.
Alcohols (principally geraniol)	66·4 to 76·3
Esters (as geranyl acetate)	9·1 to 13·3
Aldehydes and ketones (probably largely citral)	2 to 7
Residue	8·8 to 16·7

Essential oil firms in this country who were consulted regarding the commercial value of the oil considered it to be inferior to geranium oil. One firm expressed the opinion that it would find a satisfactory market at a price comparable with that of palmarosa oil, and small consignments of the oil were disposed of through this firm at the ruling price of Indian palmarosa oil. Production of the oil on a commercial scale has not, however, yet taken place, and it would appear, judging from the information available, rather doubtful whether the cultivation of the plant for the flower oil would prove a successful commercial undertaking except perhaps as part of a larger scheme of essential oil production.

A sample of the air-dried leaves of *A. Gamwelliæ* was also forwarded to the Imperial Institute for investigation. These furnished 2·7 per cent. of essential oil having a rather pleasant odour, but not so rose-like as the flower oil and distinctly more lemon-like. The quantity of the leaf oil available was insufficient for examination.

CRYPTOCARYA LATIFOLIA NUTS FROM SOUTH AFRICA

The sample of nuts which is the subject of this report was forwarded to the Imperial Institute by the Department of Overseas Trade in November 1932, under the name of "Ntonga" nuts.

The Department had received the nuts from H.M. Trade Commissioner at Durban, who stated that the nuts occur in the forests of Natal and East Griqualand and that the oil extracted from them is used locally by the natives. An analysis by the Imperial Institute was desired in order to ascertain whether there would be any market for the nuts or the oil in the United Kingdom.

The botanical source of the nuts was not stated, but through the kind assistance of the Director of the Royal Botanic Gardens, Kew, they have recently been identified as the fruits of *Cryptocarya latifolia* Sond. (Natural Order, Lauraceæ). This is a large tree, reaching a height of 60 ft., with a bole up to 3 ft. in diameter. It is known to the Zulus as "umtungwane."

The sample consisted of brown to dark brown nuts, roughly spherical in shape and slightly pointed at one end. The nuts were about 1 in. in diameter and consisted of a fairly thick woody shell and an oily kernel.

The kernels were covered with a thin, brown, papery skin, with greyish veins. Internally they were mostly pale yellow, some were pinkish-buff and a few were very dark brown. A few kernels were mouldy externally. The kernels were roughly spherical, and measured from ½ to ⅝ in. in diameter.

The sample was examined with the following results :

Nuts :		
Average weight	*grams*	4·5
Shell	*per cent.*	55·4
Kernel	,,	44·6
Kernels :		
Average weight	*grams*	2·0
Moisture	*per cent.*	4·8
Oil in kernels as received	,,	61·1
Oil, expressed on moisture-free kernels	,,	64·2
Oil, expressed on entire nuts	,,	27·3

When hot light petroleum was used for extracting the oil, the solvent also removed a brown resinous substance, which separated out on cooling. This substance was readily soluble in benzene and was easily saponifiable.

The oil as extracted from the kernels with cold light petroleum was a light brown, semi-solid fat, which had the following constants :

Specific gravity at 100/15° C.		0·8647
Melting point (by open tube method)		26·0° C.
Refractive index at 40° C.		1·4585
Acid value		56·5
Saponification value		213·0
Iodine value (Wijs, 3 hrs.)	*per cent.*	75·2
Unsaponifiable matter	*per cent.*	1·4
Soluble volatile fatty acids		11·1
Insoluble volatile fatty acids		0·3
Solidifying point of fatty acids		39·5° C.

These results show that Ntonga fat belongs to the class of "non-drying" oils. Its high saponification value of 213 is apparently due to the presence of glycerides of soluble volatile fatty acids.

The residual meal, left after the extraction of the fat from the kernels with cold light petroleum, was buff coloured, and possessed an extremely bitter taste. On examination it gave the following results :

	Per cent.
Moisture	12·8
Crude proteins	23·1
Ether extract [1]	14·7
Carbohydrates, etc. (by difference)	36·1
Crude fibre	6·7
Ash	6·6
Nutrient ratio	1 : 3·0
Food units	131

[1] *This material, extracted from the meal with sodium-dried ether, was not of the nature of fat. It was not soluble in cold light petroleum, but dissolved readily in benzene. It appeared to be of a resinous nature, and was probably identical with the resinous substance which separated from the hot petroleum extract of the kernels referred to above.*

The meal was found to contain a body (or bodies) giving positive reactions for alkaloids.

Although the meal contains a good percentage of crude proteins, its intensely bitter taste and the presence of alkaloids would render it unsuitable for use as a feeding-stuff for animals.

The results of examination showed that the kernels of these Ntonga nuts contain a high percentage of fat, but the fat is of rather dark colour and would only be suitable as a low-grade soap-making oil, for which use, however, it would not be likely to find an outlet in the United Kingdom in view of the adequate supplies of better materials already available. As an oil seed the kernels have the further disadvantage that the residual meal would not be saleable as a feeding-stuff.

ARTICLE

SCIENTIFIC ASPECTS OF CACAO FERMENTATION

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Chief Chemist, Cadbury Bros., Ltd.

PART IV

Changes in the Interior of the Bean

When the shell is removed from the cacao bean the inside consists of the minute white germ or radicle and the two interlocked cotyledons. The nibs which the cocoa and chocolate manufacturers use consist of the broken cotyledons. The colour, flavour and other changes which occur in the cotyledons during fermentation affect the properties of the cocoa and chocolate produced and are therefore of great practical importance. The changes which fermentation produces in the shell are of interest in relation to its chief use, which is as an ingredient in cattle food. Those changes in the shell which are due to substances, such as theobromine and tannin, acquired from the cotyledons, will be mentioned later, but one arising from the fermentation of the pulp will be mentioned here. Dr. Coward and the author have shown [50] that the shell of the sun-dried

fermented bean has a remarkably high potency in vitamin D (namely about one-quarter that of cod-liver oil), a potency which is not present in the original shell and is produced by fermentation of the pulp followed by drying (irradiation) in the tropical sun [56].

The following are the differences observed between unfermented and fermented beans picked out from cacao offered for sale to cocoa and chocolate manufacturers. As half-fermented cacao is not half-way between unfermented and fermented in all its properties, this is tabulated also.

FORASTERO CACAO

—	Entirely unfermented (dried direct).	Half fermented (and dried).	Fully fermented (and dried).
Shape of bean	Flat.	Flat.	Plumper.
Shell			
(1) Texture and fit	Soft and close fitting.	Hard and close fitting.	Crisp and more or less free.
(2) Colour of section	Almost white.	Light.	Pale brown.
(3) Colour, inside surface	Clean, pale.	Clean, a few have brown patches.	Showing extensive dark brown deposits.
Germ	White section.	Pale brown.	Dark brown.
Kernel (cotyledons)			
(1) Colour of section	Slate.	Bright heliotrope or claret colour.	Brown, brown-purple or brown tinged with purple.
(2) Colour of surface	Dull, dark grey.	Darker, a few show rust.	Glossy, purplish-brown, many show rust.
(3) Consistence	Leathery or cheesy.	Very hard, woody and tough.	Crisp.
(4) Appearance	Solid.	Solid.	Open grained.
(5) Taste	Bitter and astringent.	Bitter and astringent.	Less astringent.
(6) Aroma—Raw	Faintly earthy.	Slightly acid.	Acid (with faint fragrance).
Roasted	Resembles broad beans (*Vicia faba*).	Like unfermented.	Characteristic chocolate odour.

An attempt will now be made to explain what happens during fermentation and to note the causes of the changes tabulated above.

Changes in the Epidermis and the Perisperm

Both these are filmy membranes under the skin of the bean. The epidermis is little affected by fermentation,

but the perisperm is partly destroyed [12]. The author examined the epidermis of Trinidad cacao and found it to consist of polygonal cells, about 20μ (0·0008 in.) in diameter, each containing an average of nine angular granules. He failed to identify these granules—they are three-quarters the size of cacao starch and stain brown with iodine (see Fig. 1).

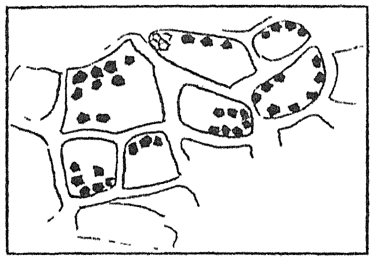

FIG. 1.—EPIDERMIS OF THE COTYLEDON SHOWING GRANULES STAINED WITH IODINE. ×600.

The perisperm, a soft colourless transparent membrane, known in the cocoa factory as "beeswing," surrounds the cotyledons. Where it lies between cotyledon and skin it shows polygonal cells 60μ (0·0024 in.) in length, but the structure is more indefinite where it lies between the cotyledons. During fermentation the part which lies between the cotyledons becomes tender and tacky and in places disappears.

Changes in the Cotyledons

In the author's experience the average composition of the raw cotyledons is as shown below :

SKINNED BEANS (FORASTERO) STRAIGHT FROM POD

APPROXIMATE COMPOSITION.

	Per cent.
Cacao butter	37·0
Moisture	33·0
Protein	6·0
Cacao starch	4·0
Mineral salts	2·2
Crude fibre	1·8
Cacao tannin, at least	1·6
Cacao catechin, at least	0·5
Theobromine	1·2
Caffeine	0·3
Unestimated (other carbohydrates, mucilage, pectin, etc.)	12·4
	100·0

A more detailed analysis of typical samples of the dried unfermented and fermented commercial cacao bean from the Gold Coast will be given in the next part.

It will be seen that the cotyledons of the fresh bean as

taken from the pod consist of one-third moisture and over one-third cacao butter. Cacao butter at ordinary temperatures is a hard fat which melts at 33° C. (91° F.), and one might expect that the change of state of so important a constituent would affect the bean during fermentation when its melting point was reached. No obvious change occurs at this temperature.

The appearance under the microscope of a section of the cotyledons of the fresh Forastero bean is characteristic owing to the presence of cells of an intense even violet colour. The transverse and horizontal sections are similar, but the cells are longer in the latter. The coloured cells, which number about 10 per cent. of the total, are larger than the others and filled with a violet substance. Unlike the other cells, they contain neither starch nor cacao butter. These cells are characteristic of all cacao beans with a purplish section whether they be Calabacillo, Forastero or Forastero-Criollo hybrids. They account for the colour of the section, whether it be deep amethyst, claret colour or pale pink. Those ordinary colourless cells which are cut through in sectioning rapidly become brown or brownish-yellow if exposed to the air. The coloured cells sometimes appear blue, possibly due to reaction with the iron from the knife used. If the beans freshly taken from the pod are not fermented but merely dried, the coloured cells do not change, except that the effect of driving off the water is to make their colour a deeper and more blue shade of violet. It does not appear to be generally recognised that the well-known misty slate colour of a section of the dry unfermented bean is solely due to the dark violet dots on a white or brownish background. This can be seen with the naked eye by scraping off a thin film with a knife. On Plate V, Fig. 1, the appearance is shown of such a film cut from a dried unfermented Forastero bean from the Gold Coast.

The Death of the Seed

The fresh pulp on the beans from a healthy pod is free from yeast or other micro-organisms, and fermentation of the pulp can only occur when these are introduced. Several of the important changes in the interior of the bean

PLATE V

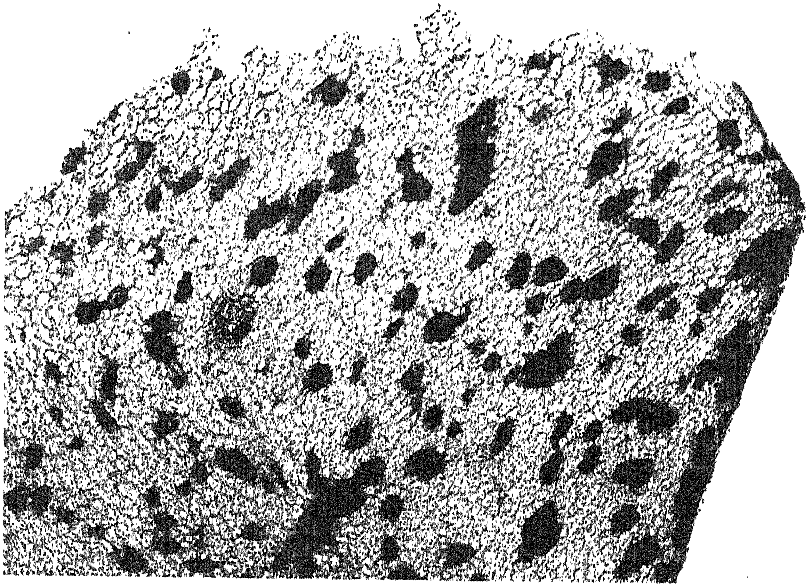

Fig. 1. Section of Cotyledon (of Dried, Unfermented Forastero Cacao), showing the Purple Pigment Cells. × 85. *Photo by L. H. Thompson.*

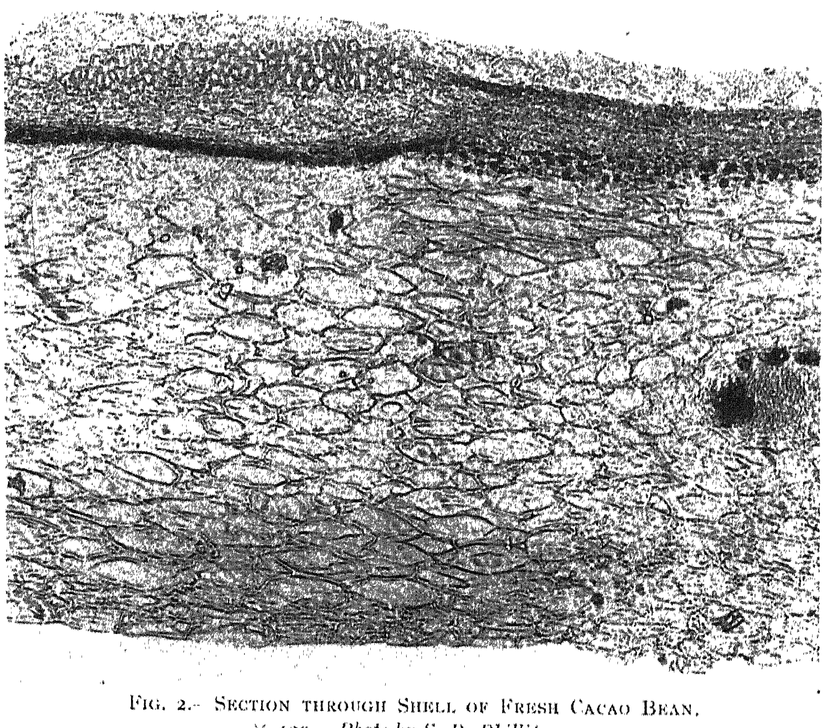

Fig. 2.—Section through Shell of Fresh Cacao Bean. × 120. *Photo by S. B. Phillips.*

depend on enzymes which exist in the bean but can only become active when the bean is killed. By a fortunate chance it happens that the fermentation of the pulp produces a temperature high enough to kill the bean, but not sufficiently high to destroy the enzymes.

By the expression " killing the bean " the author implies not only killing in the botanical sense, i.e. destroying the power to germinate, but also killing the cells of the cotyledons, etc., in the biochemical sense, i.e. producing changes which result in unhampered diffusion through the cell system of substances soluble in the cell sap. He does not include the oxidation of the tannins which occurs later, as he regards this as a reaction which follows death.

The killing of the cacao bean may be due to one or more of the following agents : (1) high temperature, (2) alcohol, and (3) acetic acid, all of which are produced by the fermentation of the external pulp. What the author has actually noted is that as the bean is killed the acid liquid of the pulp appears to gain access to the inside, affecting first the germ and then, ignoring the cell walls, apparently permeating the whole bean. It appears unlikely that the acid liquid gains access through the narrow opening of the micropyle, but rather through the seed coat itself, as we have evidence that this becomes porous. Before the killing of the bean we have a collection of cells, each containing characteristic components separated in an orderly manner. After the death of the bean, few of the components are in their original position, and all the substances present are affected during fermentation with the exception of the cacao butter and, possibly, the cacao starch.

In the fermentation of Forastero cacao in boxes, as is practised in Trinidad or on the Gold Coast, the interior of the bean shows practically no visible alteration for the first two days, the skin appearing impervious. When the beans have been fermenting for a period, depending on the temperature but averaging 60 hours, a remarkable change occurs. In the case of *heaps* on the Gold Coast, where a temperature of 45° C. is rapidly reached, this change may occur in as little as 48 hours. " The isolated pigment patches disappear, and the pigment is evenly diffused

throughout the bean. The juice of the cotyledons, formerly neutral, is now acid to litmus and this acidity changes the violet pigment from blue-violet to red-violet. Even the white germ becomes tinted red-violet. At the same time the interstices in the bean become full of a gummy, brown or brownish-purple liquid" (Knapp) [12]. In normal fermentation the author has noted that this change takes place when the temperature reaches 44° C. to 47° C. (111° F. to 117° F.). At this point the seed is killed and it becomes possible for the various substances in the bean to come in contact and react.

It may be well to pause here and enquire further respecting the death of the bean, and whether the temperature and period of heat treatment are sufficient alone to account for this. Fickendey [40] showed that the protoplasm of the cacao bean is devitalised by heating to 50° to 60° C. for one day. O. Loew [16] obtained a similar result by keeping the entire pod at 40° to 45° C. for several days. More recently Stevens [51], using pods which had been shipped from the tropics to Illinois, studied the conditions which destroy the embryo, and obtained the following results:

TEMPERATURE (° C.) AND EXPOSURE REQUIRED TO KILL THE EMBRYO

Time	45°	55°	60°	75°
20 minutes	Alive	Dead (?)	Dead (?)	Dead
30 minutes	Alive	Dead (?)	Dead	Dead
1 hour	—	—	—	Dead
2 hours	Dead	Dead	Dead	—
24 hours	Dead	Dead	Dead	—
4 days	Dead	Dead	—	—

The most useful observations for our purpose are those of J. Sack [52] who determined in the tropics the conditions which destroyed the germinating power of ripe cacao seeds:

Temperature.	Period.	Per cent. killed.
43° C.	3 hours	0
43° C.	6 hours	60
43° C.	9 hours	100
44° C.	6 hours	100

With regard to the death of the cotyledons as shown by the diffusion of the colour, the author has found that with the Forastero bean, 5 hours at 50° C. is sufficient, 24 hours

at 45° C. or 5 days at 35° C. This is the effect of temperature in the presence of the pulp—if the pulp is completely removed, the maintenance of the bean for 24 hours at 45° C. does not cause diffusion. If the pulp is replaced by cotton wool soaked in 2 per cent. acetic acid the diffusion occurs, but it does not if the cotton wool is wet with water. Whilst the observed temperature changes during fermentation are almost sufficient to account for the death of the cotyledons, there is little doubt that in a normal fermentation both alcohol and acid are contributory causes.

Busse has pointed out [46] that the whole of the bean is not killed at the same time, and that the killing of the germ (radicle) and of the cotyledons (nib) occurs at different times with different results. Busse states that the skin of the bean is killed by the alcohol produced in the liquid of the pulp, and as soon as this happens the alcohol passes through the skin and kills the germ. The killing of the germ can thus occur as soon as sufficient alcohol has been produced, even if the temperature of fermentation does not rise as high as 45° C. (113° F.). The initial conditions in fermentation are favourable to germination and it is an advantage that the capacity to germinate should be destroyed as soon as possible. All the desired results of fermentation, however, do not proceed from killing the germ, nor is it correct to conclude that because the bean can no longer germinate the whole of it is dead. According to Busse, the dying of the cotyledons proceeds gradually from the outside, and this process may not be complete until not only the fermentation, but the drying is finished. It depends on the amount of substances present which are poisonous to protoplasm, and on the temperature reached and maintained. Zeller [53] following Busse declares that it is safe to assume that as a rule the cacao bean still " lives " at the beginning of the drying process. If by this is merely meant that the browning of the cotyledons is not complete, the author concurs ; if otherwise, he would point out that in his experience in any Forastero bean which is being properly fermented, on the third day the purple colour will be found distributed throughout the cotyledons, definitely implying that the cell walls have already become pervious.

Nor does destruction proceed in all cases from the periphery towards the centre. Sometimes the diffusion of the violet substance has taken place mainly in the centre of the bean, along the joining plane of the cotyledons where presumably the alcoholic and acid liquid lay. This suggests that, at any rate in these rarer cases, the substances in the liquid, rather than the temperature, are the cause of the partial killing of the cotyledons.

Some interesting experiments of F. Hardy, in which he determined the isoelectric point of cacao protein [54 and 55] showed that if the naked embryos of Forastero cacao beans were placed in a little dilute acetic acid, rapid diffusions of the colouring matter took place where the strength of the acid reached or exceeded 0·005 per cent. by weight (p_H 3·8 to 3·0). This strength corresponds roughly with the p_H value of cacao sweatings and Hardy considers that the killing of the cacao beans during fermentation may be caused not necessarily by rise in temperature, but by acid. Hardy's theory would suggest that as the pulp is broken down, and as acetic acid is produced, a point is reached at which the acid liquid can so markedly affect the properties of the protoplasm that unhindered diffusion takes place between the various substances dispersed in the cell sap.

Hardy called attention to the production of acetic acid, and apparently assumed that the effective acidity of the pulp increases as fermentation proceeds. The evidence on this is somewhat contradictory. Schwarz [18] on the Gold Coast showed that both pulp and sweatings were more acid after two days' fermentation (p_H dropped from 4 to 3·4), but Whymper [44] on skins and pulp showed a gradual decrease in effective acidity as fermentation proceeded. Further, if one takes the p_H of the original pulp (compare Schwarz: for pulp p_H 3·8 to 4·0; for sweatings p_H 3·8; Hardy, for sweatings p_H 3·9; Whymper, for skins and pulp p_H 3·6; Laycock for husk p_H 3·4), this appears to be in the region of acidity which Hardy found effective, in which case all that is necessary is for the acid in the pulp cells to escape owing to the liquefaction produced by micro-organisms or enzymes and diffuse through the bean.

As diffusion (in ordinary box fermentation of Forastero

cacao) does not become evident before 48 to 72 hours' fermentation, we may assume either that the acid juice is insufficiently liberated from the pulp before then or that any necessary extra acidity due to fermentation has only

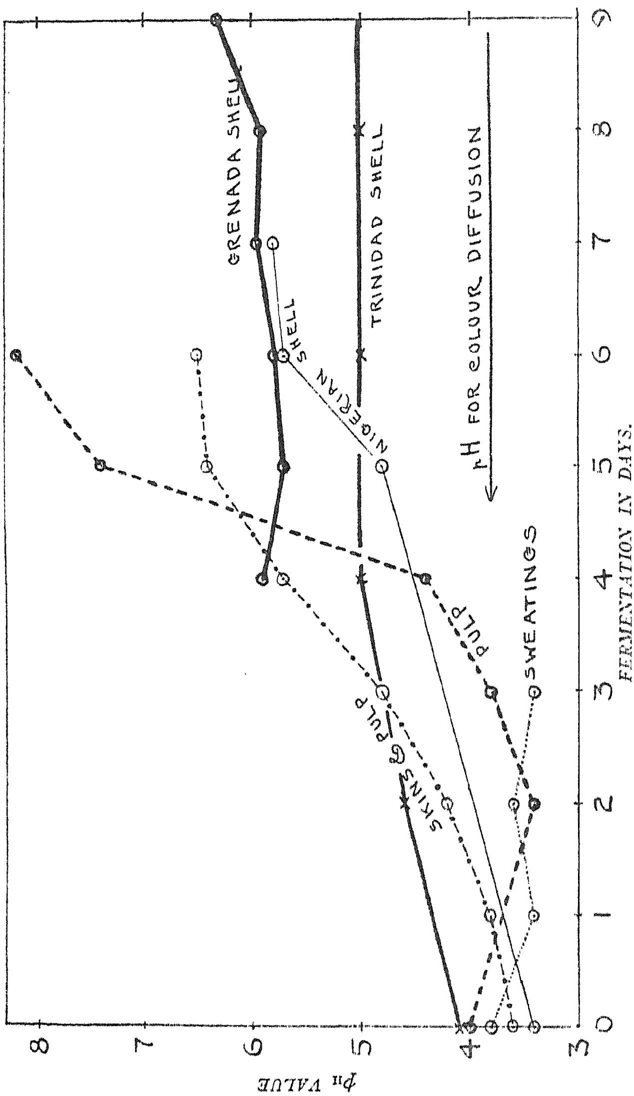

FIG. 2.—p_H OF CACAO SWEATINGS, PULP, SKINS AND SHELL.

The curves shown are drawn from :—

(1) Schwarz's figures (18) on *pulp* and *sweatings* from Gold Coast cacaof ermented in a box. A quite exceptional luxurious development of mould occurred on the fourth day. This renders the figures after this day quite abnormal. (Method : The p_H was determined by indicators and colour chart.)

(2) Whymper's figures on *skins and pulp* (44).

(3) Laycock's figure on *Nigerian cacao shell extract* (26). (Method : 1 gram shell, 20 c.c. water, boil, filter. The p_H of filtrate determined by Clark and Lubs colour chart.)

(4) Figures on *shell of commercial Grenada cacao beans* fermented in a box. (Method : Extract as in 3 using cold water. Electrometric p_H determinations with Cambridge potentiometer using Rideal-type calomel and hydrogen electrodes.)

(5) Figures on *shell of commercial Trinidad cacao beams* fermented in a box. Samples eleven years old. (Method : as in 4.)

just been produced. This latter assumption is not supported by the observed p_H values, for at 60 hours the effective acidity is less than is indicated by a p_H of 3·8. The author concludes that the acidity is neither the sole cause nor even the main cause of the diffusion. Acidity

does, however, assist temperature in killing the bean. It is worth noting that although the cotyledons pass from neutrality to a slight acidity as fermentation proceeds, their hydrogen ion cencentration never becomes anywhere in the region of p_H 3·8.

The changes in the p_H of the pulp and skins during

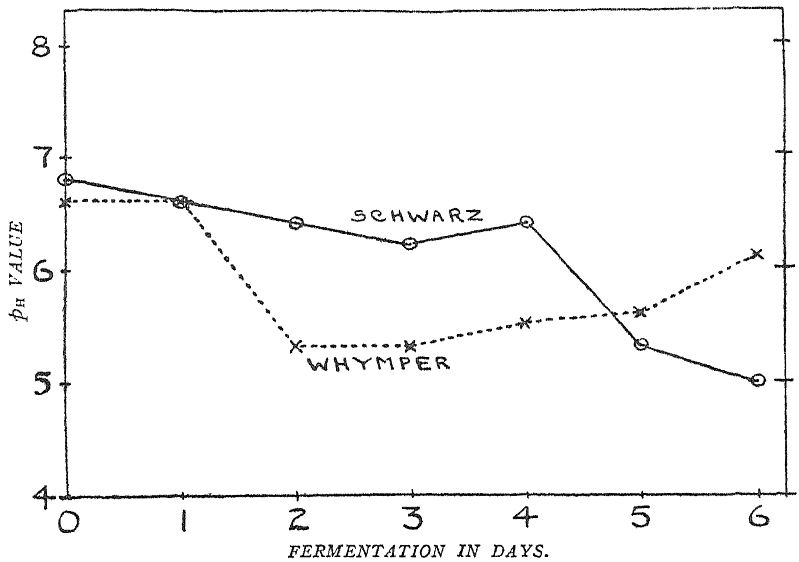

FIG. 3.—p_H OF INTERIOR OF CACAO BEAN [COTYLEDONS]. THE CURVES ARE DRAWN FROM SCHWARZ'S FIGURES ON GOLD COAST CACAO (18) AND FROM WHYMPER'S FIGURES (44).

fermentation are shown in Fig. 2 and in the p_H of the cotyledons in Fig. 3.

It has been suggested that the degree of fermentation of the cacao beans of commerce might be ascertained by determining the p_H of the shell. In the author's opinion the appearance of the inside of the bean is a safer guide to the amount of fermentation. Little has been published on the p_H of the shells from various kinds of beans. The p_H of the shell of unfermented Forastero beans varies in the few samples so far tested from 3·4 to 4·1. Further, the shell retains varying amounts of pulp and may acquire dust or mould during drying. Cacao may consist of a mixture of beans of varying degree of fermentation, and a p_H of, say, 4·5 may result from 100 per cent. partly fermented, or from a mixture of fully fermented and completely unfer-

mented. Washing the fermented bean raises the p_H of the shell.

The curves show the figures recorded by Schwarz, Whymper and Laycock, together with figures obtained by the author's assistants on box-fermented Trinidad and Grenada cacao. As an experiment the author picked out, from West African cacao, beans fitting the descriptions given in the table at the beginning of this section. They gave the following results :

Beans	Probable treatment.	p_H of shell.
Unfermented . . .	Wholly unfermented	4·0
Half fermented . . .	2 or 3 days' fermentation	4·4
Fully fermented . . .	6 days' fermentation	5·8
50 per cent. unfermented . } 50 per cent. fully fermented . }		4·5

In testing the reaction of the fresh bean, the author noted that whilst the cotyledon is neutral (p_H 7) and the radicle also neutral, the vascular tissue at the tip of the opposite end of the bean is acid (p_H about 3·5).

Diffusion Phenomena

Whilst Hardy has studied the conditions under which the naked cotyledons become permeable to acid, in fermentation it is generally assumed that the acid liquids have first to pass through the shell. They may enter via the placental attachment or pass through the shell itself. The impression gained from examination of the bean during fermentation is that the seed remains with its normal moisture until it is dead, when the shell becomes more permeable by water. The greater speed at which fermented shell absorbs water has been proved by Laycock [26].

Whymper [44] has made experiments in diffusion which give an indication of the probable absorption and effusion of water by the bean during fermentation. The beans dry out at first and later absorb moisture. These actions do not appear to be proportional to the temperature, but related to changes in the permeability of the skin. He showed that during the second and third day's fermentation the bean is able to absorb less water (and give out more) than when fresh and, in accordance with this, the beans (with pulp removed) actually contain on the third day 1 per

cent. less water than when fresh. This change takes place whilst the temperature is rising, and during this period the kernels (cotyledons) may lose some of their contents to the shell, although the author doubts this.

As we have seen, the death of the bean generally occurs on the third day. Whymper showed that on the fourth day the beans have a much increased ability to absorb water from outside. Inflation is noted on the fifth day due to absorption being in excess of effusion. After 6 days he found the cotyledons contained in their interstices over 1 per cent. more water than was originally present in the fresh bean. In this condition the slightest fracture of the skin results in a small globule of purplish-brown liquid oozing through. The bean should be tenderly handled at this stage, as puncturing the shell should always be avoided or mould or insect may later gain access. Whymper considers the avoidance of puncturing of special importance because the loss of the juice inside results in wrinkled skins and, in his opinion, causes the bean to develop an unpleasant odour.

The work of Adrian Brown, who studied with the aid of barley grains diffusion phenomena through septa, gave some clue to the behaviour of various substances and indicated that acetic acid and alcohol pass readily through septa which are permeable by water. Whymper from a study of the p_H concludes, but does not prove, that the development of acidity in the beans is not simply due to the diffusion of the acids of the pulp but to the actual formation of organic acids *in situ*.

The Juice in the Bean

It was mentioned above that when the seed is killed and the colour diffused, the spaces between the cotyledons, and between the cotyledons and the shell, become wet with a gummy, brown or brownish-purple liquid. The author found this liquid to contain a multitude of microscopic golden-yellow or orange globules, which varied in size but were mostly much smaller than the cacao starch grains, and passed through a No. 4 Whatman filter paper. In some cases the bean becomes so turgid that if it is pricked with a pin the juice spurts out; but in the early stages

flat beans may contain as much juice as round beans. The juice of the Forastero beans is purple and becomes brown on exposure to the air. Later, when the bean is dried, this juice forms dark brown patches on the inside of the shell, and a characteristic appearance of rust on the cotyledons. The presence of the patches on the shell is a useful indication that the bean has undergone a considerable amount of fermentation. Rust will be noted in over 25 per cent. of Accra beans. If this rust is examined microscopically it will be found to consist largely of yellow globules, which analysis shows are accompanied by tannin, theobromine and mineral salts. The globules are not cacao butter ; they appear to be entirely organic and not to contain nitrogen. They are slightly denser than water and insoluble in ether. The author has not identified them further.

Production of Free Shell and Open-grained Appearance of Cotyledons

The "plumping up" of the bean mentioned above occurs with all kinds of cacao, but is most difficult to obtain with Calabacillo. The period of fermentation at which the beans become notably plumper depends on the botanical variety : the nearer the variety of the cacao is to Criollo the shorter the period. The author fermented so-called Trinidad Criollo (Forastero-Criollo hybrids) and Calabacillo under identical conditions : in five days the Forastero-Criollo beans were much darker externally and as round as eggs, whilst the Calabacillo were still flat. The juice partially separates the cotyledons and stretches the skin to the utmost so that it no longer closely adheres to the cotyledons. On drying, the interior shrinks, interstices are produced in the kernels and the shell remains more or less free.

Agents and Objects

We have seen that different writers who have investigated the killing of the cacao bean during fermentation have emphasised the importance of (*a*) high temperatures, (*b*) alcohol, and (*c*) acid (acetic or citric). All these are present in a normal fermentation and play their part, and there is no agreement by which of these agents—singly or in combination—the finest cacao can be produced. The

question will be referred to later in the discussion of variations on fermentation.

It has sometimes been suggested that two important objects of fermentation are to kill the germ and ensure a stable product. By merely drying in the tropical sun the power of germination is destroyed, but there is not usually any diffusion of substances in the cotyledons. Therefore, contrary to the opinion of some planters and brokers, the dried unfermented bean shows not the slightest inclination to germinate, and if containing less than 6 per cent. of water, changes very little in any respect though stored for years ; after twenty years the isolated patches of violet pigment can still be seen. When, however, the cacao has been fermented, the purple beans will continue to change slowly towards brown as long as the cacao contains more than 8 per cent. of water.

Although the author has seen yeasts, etc., inside the fermented and dried beans of commerce, these presumably gained entry through fractures in the shell, for in watching fermentations he has never found micro-organisms inside the skin of the bean.

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(*To be continued*)

NOTES

The East African Agricultural Journal.—The need for a technical periodical devoted specially to East African agriculture has long been felt. This gap has now been filled by the issue, under the authority of the East African Governor's Conference, of *The East African Agricultural Journal*.

The new periodical, which is to appear in alternate months from January to November of each year, is edited by Mr. W. Nowell, Director of the East African Agricultural Research Station at Amani, with an Editorial Board consisting of the Directors of Agriculture in Kenya, Tanganyika, Uganda and Zanzibar. The contents consist principally of instructive technical articles by members of the staffs of the Amani Station and of the four Departments of Agriculture, and as illustrating the comprehensive scope of the *Journal* the following titles of some of those appearing in the two first issues may be quoted: The Inoculation of Leguminous Crops; Measures Against Soil Erosion in Tanganyika; Sugar-cane Diseases in Uganda; Coffee Shade in Kenya; Tea Cultivation in the Southern Highlands of Tanganyika; Overstocking in Kenya; Virus Diseases of East African Plants; A Simple System of Farm Accounts and Records; The Climate and Weather of East and Central Africa.

The immediate object of the periodical may be indicated by the following quotation from Mr. H. B. Waters' "Foreword" in the first number:

"The *Journal* should make a wide appeal not only to those whose livelihood is farming, but also to those whose well-being depends on agriculture; and in these territories, where prosperity and the advancement and development of agriculture march hand in hand, it is difficult to think of any section of the community whose interests are not largely affected by agricultural progress.

"By keeping farmers in touch with the progress of successful agriculture throughout East Africa it is hoped that the *Journal* will assist them in their efforts to improve farming methods. The *Journal* should also serve a useful purpose by strengthening the ties between agricultural communities who have common interests in neighbouring territories."

A high standard has been set up in the first issues, and in view of the authoritative auspices under which it is published it should prove of great interest and utility to a wide circle of readers, not only in East Africa, but in many other parts of the Empire.

The *Journal* is obtainable from the Government Printer, P.O. Box 128, Nairobi, price 1*s*. per copy, or 5*s*. per annum.

Orange Culture in Nigeria.—Reference has already been made in this BULLETIN (1935, **33**, 70, 368) to the experimental work which is being conducted by the Agricultural Department, Nigeria, on the introduction of improved forms of various citrus fruits, including oranges. The object in view at the moment is to raise the quality of the fruit for local consumption, but the possibility of establishing a regular export trade in the future is also being borne in mind.

The oranges at present produced in Nigeria are of relatively low quality as compared with the standard ordinarily demanded in the United Kingdom. Small shipments were made to this country in 1932 and again in 1933. They were disposed of in Liverpool at a rather low price which left only a very small profit after paying all expenses. Nevertheless, the business is regarded by the authorities as a promising one, and steps are being taken to improve the standard of selection and packing of the fruit. With this end in view Orange Export Regulations (No. 20 of 1935) have been made under the Agricultural Ordinance, 1926.

These Regulations apply to the Colony and Protectorate (including the Cameroons under British mandate) and came into force on October 1, 1935. They lay down that no oranges shall be exported from Nigeria for sale unless (1) they are of a type, condition and degree of maturity approved for export and are free from bruises; (2) each orange is wrapped in a manner approved for export; (3) all oranges in any one box are of a similar type and size; and (4) the oranges are packed in boxes of prescribed dimensions and graded in specified sizes. Provision is also made in the Regulations for the labelling and marking of the boxes and for the inspection of the oranges by an officer appointed by the Agricultural Department.

Any person who exports oranges without a certificate from the Inspector that the prescribed conditions have been satisfied is liable to a fine of £50.

The Bronzing of Tung Trees.—In connection with the cultivation of Tung trees in Florida, an unthrifty condition of many trees, locally known as "bronzing," has been the cause of loss in many groves. Within the past few years this trouble has occurred with increasing severity and has

affected not only many newly planted groves, but to a greater degree some of the older plantations which, during the early years of the life of the trees, had been apparently fairly free from it.

With a view to finding a remedy for the trouble, experiments were started in 1931 at the Agricultural Experiment Station, Gainesville, Florida, and the results of the preliminary trials carried out have been published in the Station's *Bulletin* No. 273, from which the following information has been abstracted.

" Bronzing " of Tung trees is a non-parasitic disease which has made its appearance in plantations over a wide area and for which no remedy, prior to the present experiments, had been found, the use of the common fertilisers, cultivation methods and cover-cropping being of no avail. The severity of the attack has varied. In some cases the growth of the tree has been stopped, while in more severe cases the tree has died within two or three seasons. Further, a " bronzed " tree is materially weakened and is subject to damage by ordinary low temperatures which are not injurious to vigorous trees.

The first noticeable symptom displayed by trees affected by this disease is a bronzed coloration of a few or many leaves with a slight or severe deformation of the terminal leaves. The foliage later becomes of a typical dark bronze colour, more or less spotted, and ultimately parts of the leaves die, giving them a ragged appearance. On newly affected trees the trouble usually starts in the very late spring or early summer, but seldom appears with the first growth of the season, while it may not become evident until very late summer or early autumn. Following the appearance of the first symptoms the severity of the disease usually increases rapidly. During the first season the trouble may be confined to one limb only and that branch may become badly diseased before any of the remainder of the tree is visibly affected, but eventually the whole tree becomes " bronzed."

The age of the tree when it first shows the symptoms of the disease varies considerably. In many cases the tree may be several years old before showing any damage and may thrive during that period. On the other hand, in some plantations trees have developed the disease during the first year after transplanting, and nursery stock in its first season has also been affected.

Whether there is any relationship between bronzing and the type of soil appears to be uncertain. It has been observed that the disease commonly occurs where the amount of natural phosphatic materials in the soil may be

excessive for Tung trees, and in a number of very severe cases the land has been under cultivation for many years and the soil therefore depleted. On the other hand, the disease is not limited to old soils, but has occurred on newly cleared land.

The only remedy so far discovered for bronzing of Tung trees is an application of zinc sulphate. This substance may be administered either in the form of a spray or by direct application to the soil. For trees under four years of age where only a small amount of bronzing has occurred a treatment of 4 oz. of zinc sulphate (containing 89 per cent. of the anhydrous salt) per tree should be beneficial. This should be applied round the trees in April or May, and if they still show bronzing later an additional application of 4 to 8 oz. per tree may be made. For older trees more severely affected, treatments of 1 lb. or more will be necessary. It is advisable that no more zinc sulphate is used than is necessary to eliminate the bronzing.

Alternatively, a small application may be given to a plantation in April, irrespective of the presence or absence of symptoms of the disease, and this may be followed in June by a further application to those trees which subsequently develop bronzing.

In the event of the affected trees not responding to the application of zinc sulphate to the soil, the use of a spray consisting of 5 lb. of sulphate and 5 lb. of lime to 50 gallons of water is recommended. It is important that the whole of the tree should be sprayed and not the affected parts only.

These recommendations cannot be regarded as more than of a temporary nature, since the experimental work summarised above has not been continued sufficiently long to answer definitely the question of optimum times and amounts of applications of zinc or even the form of application, since either new salts or new methods of application may prove eventually to be more successful than the application of zinc sulphate to the soil.

An interesting point brought out in the report is the widespread nature of the disease. Other crops adjoining badly bronzed Tung trees were found to be affected. Satsuma oranges suffered from chlorosis ("frenching"), pecan trees from "rosette" disease and maize from "white bud," and all these, like the bronzing, respond to treatment with zinc sulphate. Whether the trouble is due to a deficiency of zinc in the soil or whether it is a condition that can be corrected by the physiological action of zinc has yet to be determined.

Paper from Maize Stalks.—Despite numerous investigations and the patenting of many processes, the commercial utilisation of the large quantity of fibrous materials annually available in the form of maize stalks has not yet been successfully achieved. Moreover, the literature on the subject is deficient in details of the most satisfactory methods of pulping and of the qualities of the pulps that can be produced. In order to obtain information as to the precise value of maize stalks as a paper-making material an investigation was undertaken by the National Bureau of Standards of the United States Department of Commerce. The results have been published by the Bureau in a paper entitled " Paper-making Quality of Cornstalks," by C. G. Weber, M. B. Shaw and M. J. O'Leary (*Miscellaneous Publication* M147, 1935).

Difficulties in the manufacture of paper from maize stalks arise from the structural peculiarities of the stems. The cortex contains fibres shorter than those of the most commonly used woods, but, nevertheless, of paper-making quality ; whereas the soft, spongy, inner pith consists chiefly of thin-walled cells of little use for paper-making. Furthermore, hard nodes occur in the cortex and must be crushed in order to obtain an evenly cooked pulp. An excessive amount of dirt is also liable to be present.

A series of laboratory and semi-commercial tests were carried out, using the material in three different forms, viz. (1) the stalks in 1 in. lengths, (2) the shredded stalks, (3) the separated and washed cortex. Papers were made by the lime, caustic soda and sulphate processes, and details are given of the yield of pulp and the qualities of the paper obtained in each trial. The cleanest, strongest, best-working papers were produced from the separated cortex, which yielded only 5 per cent. less pulp (expressed on the original baled stalks) than was obtained from treating either the cut or the shredded stalks. As, moreover, the cut or the shredded stalks, constituting 85 per cent. of the original material, require twice the quantity of chemicals and twice the digester capacity needed for the cortex, which amounts to only 43 per cent. of the original material, the advantage and economy of using the cortex only is evident.

Owing to the low strength of maize stalk fibres, the utilisation of the unbleached pulps for the manufacture of brown wrapping paper proved impracticable, the papers produced being of poor quality and without commercial possibilities. White pulp of a quality satisfactory for medium grades of writing papers was successfully prepared from cortex that had been thoroughly dusted before cooking. The best paper from this pulp possessed good colour

and cleanliness and exceeded the strength requirements of the United States Government Printing Office Specifications. It is also probable that a greaseproof paper comparable to the grades commonly used for wrapping butter, lard, etc., could be produced.

It is estimated that 5·2 tons of maize stalks would be required to give enough cortex to produce 1 ton of pulp suitable for white papers. Assuming that the price of the stalks at the mill is \$7·15 per ton and that \$1 per ton must be allowed for the separation of the cortex, the cost of the stalks would be \$42·38 per ton of pulp. This is about 60 per cent. greater than the cost of the spruce wood required for a ton of sulphite pulp, and in addition the conversion and handling costs would be higher.

In conclusion, the authors express the opinion that, on account of the relatively high cost of the raw material and the expense of converting it into pulp, the manufacture of paper from maize stalks is not at the present time a commercially feasible venture. Only if sufficiently profitable uses could be developed for the pith and fine fibrous material left after separating the cortex, could the stalks become of interest to the paper-maker.

Oil Content of Indian Palmarosa Grass.—An investigation has been carried out at the Punjab Agricultural College by Girdhari Lall with a view to determining the seasonal variations in the amount of oil in the leaves, flower-heads and stalks of palmarosa grass (*Cymbopogon Martini* var. *Motia*), and with the object of ascertaining the effect on the oil content of frost and also of stacking the crop before frost (*Indian Journ. Agric. Sci.*, 1935, **5**, 415). It had been previously observed in connection with palmarosa grass under cultivation near Jaranwala, Punjab, that if the crop was not distilled before the onset of frost the yield of oil was seriously affected, and it was thought that cutting and stacking the grass before the appearance of frost might arrest the decline in the oil content.

The experiments, which were conducted during the season August 1932 to March 1933, showed that throughout the season the leaves yielded the largest amount of oil, which rose from 1·23 per cent. in August to a maximum of 1·39 per cent. in the middle of October when the flowers appeared, and then gradually fell to a minimum of 0·77 per cent. at the beginning of March. The oil content of the flower-heads reached a maximum of 1·37 per cent. at the end of October and then declined to 0·56 per cent. in the middle of January, when the last determination was made. The oil content of the stalks, estimated at intervals from

August to the end of September, was found to amount to about 0·03 per cent. Seasonal changes similarly affected the oil content of the entire plant, the maximum yield of oil, viz. 0·40 per cent., being obtained during the fourth week in October when the grass was fully matured.

All the above percentage figures have been calculated on the moisture-free material.

Intermittent attacks of frost, commencing at the beginning of December, were shown to have decreased the oil content of leaves, flower-heads and the entire plant to the extent of 13 per cent., 59 per cent. and 32 per cent. respectively. The author's experiments showed that cutting and stacking the grass before the frosts did not arrest the decline in the oil content, and, indeed, the standing crop, although attacked by frost, yielded more oil than the stacked grass up to the end of January. The stacked grass represented the fully matured crop, harvested on November 21 and dried in the sun for four days previous to stacking. Periodic distillations of this material were then carried out on the same dates as those conducted on samples of the standing crop.

Chemical examination of the oil from the different parts of the plant carried out by the author indicated that the oil of best quality was obtained from the leaves, whilst the stacked grass gave the oil of poorest quality.

The above yields of oil were obtained by the author as the result of small-scale laboratory distillations under conditions which could not be expected to give the highest possible yield of oil from the materials examined. It will be of interest in this connection to refer to the yields obtained by R. S. Pearson in an investigation of methods of distilling palmarosa grass (*Indian Forest Records*, 1916, **6**, 191). The fresh green grass was shown by Pearson to furnish a higher yield of oil than the sun-dried grass which is usually employed by the local distillers in the Melghat Division of the Central Provinces, where his experiments were carried out. He obtained an average yield of 1·29 per cent. of oil from the whole fresh grass, equivalent to 1·9 per cent. on the sun-dried grass not calculated on the moisture-free basis. These figures are appreciably higher than the highest yields obtained by the present author, viz. 0·89 per cent. from the fresh leaves or 1·39 per cent. calculated on the moisture-free leaves.

Pearson also quotes (*loc. cit.*) the following percentage yields obtained by a Bombay firm on distilling fairly fresh palmarosa grass grown in Khandesh, Bombay Presidency : leaves, 1·32 ; flower-heads, 1·71 ; stalks, 0·04 ; entire plant, 0·87. These figures are for palmarosa grass assumed

to contain 50 per cent. of moisture, and are thus also considerably higher than the yields obtained by the present author.

Reference may also be made here to distillation experiments recently carried out by the Seychelles Department of Agriculture with palmarosa grass (see this BULLETIN, 1934, **32**, 518), which show on the other hand very much lower yields of oil, viz., whole plants from about 0·22 to 0·28 per cent., heads 0·60 per cent., and stems (presumably including leaves) 0·11 per cent.

Preservation of Mine Timber.—An interesting report on experiments carried out by the Forest Products Research Laboratory on the preservation of timber used in mines has been issued by the Department of Scientific and Industrial Research (*Forest Products Research Records*, No. 3, H.M. Stationery Office, price 6*d*.).

Although timber to the value of about £6,000,000 is used every year in the mines of the United Kingdom, it is estimated that less than 2 per cent. receives any preservative treatment. This, the report states, is somewhat surprising in view of the enormous loss of timber in mines that is due to wood-destroying fungi and the ease with which fungus attack may be prevented. In some circumstances decay is exceedingly rapid and the timber has only a very short life if not treated with preservative. In such cases the timber maintenance costs are high, and it is here that the value of preserved timber is most pronounced. The cost of the actual timber used in replacements may be relatively small, the labour costs and delays resulting from falls being the factors that make for high maintenance costs. Fungal decay is accompanied by considerable reduction in strength, and the failure of timbers may often be due to incipient decay rather than to lack of initial strength. Thus, apart from its economic value, preservative treatment may have a considerable influence on the safety of the underground roads.

The experiments dealt with in the report were carried out at two pits, the Langton pit, Pinxton, near Nottingham, and the Woolmet pit at Portobello, near Edinburgh. At the pithead, batches of home-grown and imported Scots pine props were treated with solutions of the following preservatives: sodium chloride (common salt), zinc chloride, sodium fluoride and Wolman salts, and placed in workings at about 800 ft. below the surface. Creosote was not considered in the original scheme on account of its cost and reputed objections of smell and dirtiness. These objections were not considered serious by the management

at Pinxton Colleries, and on their suggestion creosoted timber was included in the tests at Langton pit.

Inspections were carried out at half-yearly intervals, the last inspection being made $4\frac{1}{2}$–5 years after the props had been placed in position. The results are summarised in a table in the report, from which the following figures are abstracted :

Out of 50 untreated props, after $3\frac{1}{2}$ years in the main return airway and other positions in the Langton pit : none sound.
Similar props treated with a 2 per cent. solution of Wolman salts : 48 sound.
Fifty home-grown props treated with a 5 per cent. solution of zinc chloride : 40 sound.
A similar number treated with a 2 per cent. zinc chloride solution : 33 sound.
With 4 and 2 per cent. solutions of sodium fluoride : 46 and 45 sound respectively.
Treated with creosote : 40 sound.

Similar results are given for the Woolmet pit, e.g. :

Fifty untreated props : none sound.
Treated with Wolman salts, 5 and 2 per cent. solutions : 44 and 40 sound respectively.
Treated with common salt, 10 and 5 per cent. solutions : 34 and 25 sound respectively.

The report indicates the estimated cost for treating props commercially with the various preservative solutions. For 6-ft. props (0·8 c. ft.) the figures work out as follows :

5 and 2 per cent. Wolman salts : 4·8*d.* and 2·6*d.* respectively.
4 and 2 per cent. sodium fluoride : 3·3*d.* and 2·2*d.*
5 and 2 per cent. zinc chloride : 2·1*d.* and 1·6*d.*
10 and 5 per cent. solutions of common salt : 1·6*d.* and 1·4*d.*
Creosote : 6*d.*

Although definite conclusions cannot be drawn at this stage of the tests, it is possible to form some estimate of the value of the preservative treatments. The more expensive preservatives, namely, creosote, Wolman salts and sodium fluoride, are giving the best results at both pits ; sodium chloride is having the least preservative effect, but even this treatment, at a conservative estimate, doubles the life of the timber. The effect of the better preservatives will be to lengthen it considerably more, so

that the economy of preservative treatment is amply demonstrated.

Seasoning of Timber.—A further publication in the series of *Forest Products Research Records* (No. 4), issued by the Department of Scientific and Industrial Research, and published by H.M. Stationery Office (price *6d.*), deals with timber seasoning. It is intended as a brief guide to the correct and economic drying of timber. The principles and recommendations laid down apply, it is stated, to timber generally and not necessarily to individual species. The advantages of air seasoning and kiln seasoning are discussed in some detail.

An interesting point brought out in the pamphlet is that it is not possible to dry timber out of doors in this country sufficiently for use in artificially heated buildings. Under the most favourable circumstances the moisture content might conceivably be reduced to about 12 per cent. in the height of summer, but 18 per cent. represents a far more usual figure, whereas a moisture content of 9 to 12 per cent. is required for interior woodwork in centrally heated buildings.

Methods for checking the progress of seasoning are described and suggestions are given regarding the piling of the timber and drying rates and times, and, in the case of air seasoning, regarding the best time of year to pile.

It is pointed out that certain refractory hardwoods, which take months to season in a kiln, if allowed to air-season for a year or so beforehand, can be kiln-seasoned in a week or two. The pamphlet deals with the means of preventing damage to timber during the seasoning process. Unfortunately, the conditions least likely to lead to splitting and checking are those most suitable for the development of stain, mould and other fungus growth, which always requires the presence of a certain amount of moisture in the wood. Fortunately, however, in general, the timbers most susceptible to fungus attack are those most tolerant of severe drying conditions.

Boron in Soils and Irrigation Waters.—The occurrence of boron in soils and irrigation waters has only recently been studied, but sufficient information has now been obtained to indicate that this element is essential to the growth of many plants, although it is highly toxic to some when present in the soil solution in concentrations of more than a few parts per million.

Technical Bulletin No. 448 of the United States Department of Agriculture, "Boron in Soils and Irrigation Water,

and its effect on Plants, with particular reference to the San Joaquin Valley of California" (131 pp.), by F. M. Eaton, describes the results of an extensive investigation of this problem.

Earlier work indicated that the boron requirement of some plants is very small, but that figs, cotton, grapes, alfalfa, beet and asparagus require more than a trace for proper development, and in many cases of plants not actually suffering from boron deficiency the addition of a small amount of this element has proved beneficial.

The effect of an excessive amount of boron is, however, of greater importance. In 1926 the presence of boron in irrigation waters was established as the cause of the poor condition of certain citrus and walnut groves in S. California, and further investigation showed that this effect was widespread. Evidence of boron injury is manifested in the foliage of many plants by the yellowing and subsequent death of the marginal tissue. These effects normally appear first at the tips of the leaves, and as more of the margin is affected, progress towards the mid-vein or leaf base. Chlorophyll is retained longer in tissues near the leaf veins. The leaves become " cupped " when marginal injury occurs in advance of full development and affected leaves fall prematurely.

The stone fruits, which rarely have leaf symptoms indicative of boron injury, are otherwise affected. The bark immediately below the nodes of prunes and apricots becomes thickened and with the excessive growth of underlying wood the structures at the bases of leaves and twigs become enlarged. The bark above the leaf and twig insertions of peaches and prunes often breaks down and splits open. Gumming frequently accompanies these abnormalities and death of the terminal growth late in the summer or over winter is a common effect. Some stone fruits may make little growth or die without the development of marked symptoms. In pear and apple, symptoms adequate for field diagnosis are not known, yet these plants are sensitive to boron.

Some 4,000 surface and underground waters from the western portion of the United States have been examined, and boron has been detected in every sample, but in amounts varying widely according to the geological formation from which the water was derived. The streams entering the valley, which arise from the granitic, metamorphic, sedimentary and igneous formations of pre-Cretaceous age of the high Sierra Nevada contain little boron or other mineral matter. Smaller streams draining mountains practically free from granitic and similar rocks,

but with soft serpentines, shales and sandstones of Cretaceous and Tertiary age are, more highly mineralised and commonly contain appreciable amounts of boron, some containing sufficient to inhibit the growth of irrigated plants.

Boron applied in irrigation water tends to be fixed in the soil, and ill-effects may appear only after a number of seasons. It is advisable, therefore, in the case of proposed irrigation schemes to examine thoroughly the proposed water supply and the soil, and to ascertain the prevailing rainfall, so that the accumulation of toxic concentrations of boron, after some years of treatment, may be avoided.

Practical methods of removing boron from irrigation waters or counteracting its toxic effect in soils have not been discovered, but citrus plants appear to be better able to withstand boron when liberal dressings of nitrates are applied. When the soil is leached with good water the productivity of light soils contaminated with boron is usually restored more rapidly than is that of heavy soils, but the process is often slow. Boron concentrations in waters as low as 0·5 parts per million are injurious to boron-sensitive crops in the more arid part of the San Joaquin Valley, and when the boron exceeds 2 parts per million, boron-tolerant crops are essential for good results. A study of the relative resistances to boron of fifty-four plants has been made.

An extension of this work to the study of other crops would be of interest. It is noteworthy that A. W. Knapp (this BULLETIN, 1935, **33,** 311) considers that the amount of boron in the soil may be of importance in growing cacao, as some cacao beans have been found to contain boron equivalent to about 0·05 per cent. of boric acid.

RECENT RESEARCH ON EMPIRE PRODUCTS

A Record of Work conducted by Government Technical Departments Overseas

AGRICULTURE

BEVERAGES

Cocoa

Gold Coast.—The following report on investigations on cocoa conducted during the period January–June 1935 has been furnished by the Acting Director of Agriculture.

In connection with the work on the moulding of cocoa, a point of considerable importance has emerged from some experiments conducted by the Mycologist on the equilibria

between water content of cocoa and atmospheric humidity. Speaking generally, in normal atmospheric conditions in the Gold Coast cocoa which has been properly dried during preparation will not during storage reabsorb moisture to a degree sufficient to induce the growth of moulds, that is to say, above approximately 8 per cent. The fact has now emerged, however, that this normal equilibrium breaks down when active moulding has once begun, even though the cocoa may afterwards have been dried to 8 per cent. water content. The effect of the moulds is to change the water-absorbing properties of cocoa so that, in an atmosphere safe for the storage of cocoa free from mould, cocoa which is actively moulded will go on absorbing moisture beyond the normal equilibrium point and moulding proceeds progressively. The importance, therefore, of thorough drying and prevention of mould in the initial stages is obvious.

The Entomologist is now working on the collection and breeding of a small braconid parasite, *Dasyscapus parvipennis* Gahan, with a view to assisting the Government of Trinidad in the control of red-banded cocoa thrips (*Heliothrips rubracinctus*), which is causing much damage in that colony. This parasite was first identified some years ago in the Gold Coast, and it is hoped that successful consignments of the minute insect can be sent to Trinidad by using the South American air mail from the Gambia.

Leeward Islands.—*Dominica.*—According to the report of Mr. F. G. Harcourt, Agricultural Superintendent, for the half-year January–June 1935, experiments have been commenced in the Economic Section of the Botanic Gardens on the cultivation of improved strains of cocoa. Cocoa pods, selected specially by the officers of the Cocoa Research Scheme in Trinidad, have been sent to the Department by the Commissioner of Agriculture with the object of planting a row of seven seedlings raised from each selected tree. Most of the seedlings were planted out in September 1934, and by the end of the year had made good growth and appeared to have become well established. Seedlings from these selections were also distributed to the two principal cocoa-producing estates.

Coffee

Uganda.—The following account of coffee experiments at the Bukalasa Experiment Station is taken from a report on work carried out during the period January–June 1935, furnished by the Director of Agriculture. It is pointed out that the results should be interpreted with caution as

experiments have not been carried on for a sufficiently long period to enable definite conclusions to be reached.

(*a*) *Shade and Ground Treatment Experiment.*—The following table summarises the results from three years of bearing :

YIELDS OF WET CHERRY EXPRESSED IN LB. PER ACRE

—	Least significant difference.	No shade.	Banana shade.	Gliricidia shade.
1932–33	2,569	14,825	11,505	13,237
1933–34		30,387	27,320	25,257
1934–35		15,022	15,466	15,958
1932–35	4,449	60,234	54,291	54,452
Clean weeded	6,293	66,199	62,553	55,930
Cover crop		54,268	46,028	52,974

—	Least significant difference.	Clean weeded.	Cover crop.	Yearly totals.	Least significant difference.
1932–33	2,097	16,889	9,489	13,189	1,483
1933–34		27,800	27,509	27,655	
1934–35		16,871	14,092	15,482	
1932–35	3,634	61,560	51,090	56,326	—

The conclusions are as follows :

Years : Second year > third year > first year.

Shades : No shade > banana shade and gliricidia shade.

Covers : Clean weeded > cover crop.

Interactions (*1st order*).

Shades × Covers : (*a*) Clean weeding is better than the cover crop under no shade and banana shade ; (*b*) no shade and banana shade > gliricidia shade when the ground is clean weeded ; (*c*) no shade and gliricidia shade > banana shade with the cover crop. That is : banana-shaded plots are spoilt badly by a cover crop ; unshaded plots are also depressed by a cover crop ; gliricidia-shaded plots are not significantly depressed by a cover crop.

Shades × Years : (*a*) No difference between banana shade and gliricidia shade at any time ; (*b*) no shade good in the first year, i.e. better than banana shade ; no shade better in the second year, i.e. better than banana shade and gliricidia shade ; no shade drops in the third year, i.e. to the same level as banana shade and gliricidia shade.

Covers × Years : Clean weeding is very successful in the first year ; it shows no advantage in the second year ;

and it is again better than the cover crop in the third year, but only equal in yield to the first year whereas the cover crop in the third year does much better than in the first year.

Interaction (*2nd order*). None.

(*b*) *Ground Treatment Experiment.*—The experiment came into bearing this season with the following results :

YIELDS OF WET CHERRY EXPRESSED IN LB. PER ACRE

Clean weeding	3,321
Elephant-grass mulch . .	3,430
Permanent cover crop . .	1,052
Weed cover	880
Least significant difference .	970

The conclusions are self-evident.

SUGAR

Cane

Leeward Islands.—*Antigua.*—The report by Mr. F. H. S. Warneford, Agricultural Superintendent, on investigational work conducted in Antigua during the period January–June 1935 contains the following account of experiments with sugar-cane.

Thirteen experiments with plant cane—three varietal and ten manurial and cultural were reaped during the season under review. Four manurial experiments with first ratoons were also reaped during this period. These seventeen experiments were conducted in collaboration with the Antigua Sugar-cane Investigation Committee (founded 1933) and under the direction of Mr. P. E. Turner, M.Sc., F.I.C., Adviser in Sugar-cane Experiments to the Commissioner of Agriculture ; the results are being analysed statistically in his office, and it will not be possible to report until the analyses are completed.

Certain of the small-scale varietal experiments reaped as plant canes during 1934 were reaped as first ratoons during the present season ; the results are presented below in Tables I to IV.

TABLE I

TOMLINSONS

Soil Type : Clay tuff (saline).
Reaped as plant cane : February 23 to 27, 1934.
,, ,, first ratoons : March 4, 1935.

Variety.	Mean yield in tons per acre.
P.O.J.2878	12·5
Co.213	12·0

Of the seven varieties reaped as plant cane these two were the only ones which ratooned sufficiently well to be worth weighing.

TABLE II

PARRYS

Soil Type: Deep calcareous.
Reaped as plant cane: March 14 to 17, 1934.
„ „ first ratoons: April 2, 1935.
Rainfall: March 1934 to March 1935, 44·52 in.

Variety.	Mean yield in tons per acre.
B.726	27·0
P.O.J.2878	25·8
B.891	22·4
G.119	21·5
B.3922	18·7
B.374	18·0
B.6308 (Standard)	12·2

TABLE III

YORKS

Soil Type: Alluvial.
Reaped as plant cane: March 20 to 21, 1934.
„ „ first ratoons: March 8, 1935.
Rainfall: April 1934 to February 1935, 35·27 in.

Variety.	Mean yield in tons per acre.
P.O.J.2878	15·9
B.726	12·9
B.891	11·0
B.374	10·5
Co.213	10·1
B.4507	9·25
B.6308 (Standard)	7·50

TABLE IV

THE COTTON

Soil Type: Calcareous.
Reaped as plant cane: April 25 to 27, 1934.
„ „ first ratoons: March 29, 1935.
Rainfall: May 1934 to March 28, 1935, 34·18 in.

Variety.	Mean yield in tons per acre.
P.O.J.2878	25·2
B.11569	24·2
B.891	21·1
B.726	17·1
G.119	15·6
B.374	15·2

The standard variety, B.4507, was so badly suppressed that rows of standard were not weighed.

As stated in the report for the period January–June 1934 (this BULLETIN, 1934, **32**, 570), the layout of these experiments, while allowing for eight replicates, has not been found entirely satisfactory—the single rows of the standard variety tending to allow suppression by more vigorous varieties in adjacent plots.

St. Kitts-Nevis.—The results of experiments on sugar-cane conducted by the Agricultural Department, St. Kitts-Nevis, given in the following tables, are taken from

the report by Mr. R. E. Kelsick, Agricultural Superintendent, on investigation work undertaken during the half-year ended June 30, 1935.

TABLE I

Variety Trial, Camp Estate

PLANT CANES

Planted: November 7, 1933.
Reaped: February 11 to 13, 1935.
Manurial treatment: 25 tons pen manure per acre and 1 cwt. sulphate of ammonia per acre on February 2, 1934, and 2 cwts. of the same manure on May 19, 1934.
System of replication: Six randomised blocks, each variety repeated twice in each block.
Area of each plot: $\frac{1}{30}$ acre weighed. Border rows discarded.
Soil: Sandy loam.

Rainfall:		
	November and December 1933 .	15·67 in.
	January to December 1934 .	46·84 ,,
	January and February 1935 .	3·71 ,,
	Total .	66·22 ,,

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb. per gallon.	Purity.	Sucrose in juice.	
	Tons per acre.	Per cent. of mean.				lb. per acre.	Tons per acre.
B.2935 .	47·71	114·0	62·4	1·599	85·9	9,950	4·44
S.C.12.4 .	36·00	86·0	58·4	1·774	88·9	7,770	3·47
Mean .	41·86	100·0	60·4	1·687	87·4	8,860	3·96

The data in the above table are the means of 12 plots or analyses.

The standard error of the difference between any two mean yields is 1·50 tons cane per acre and a difference of 3·20 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE II

Variety Trial, College Estate

PLANT CANES (EARLY REAPING)

Planted: November 25 to 27, 1933.
Reaped: February 20 to 23, 1935.
Manurial treatment: 25 tons pen manure per acre before planting and 3 cwts. sulphate of ammonia per acre, 1 cwt. early and 2 cwts. late.
System of replication: Two 5 × 5 Latin squares.
Area of each plot: $\frac{1}{30}$ acre weighed. Border rows discarded.
Soil: Sandy loam.

Rainfall:		
	November and December 1933 .	15·05 in.
	January to December 1934 .	48·36 ,,
	January and February 1935 .	5·30 ,,
	Total .	68·61 ,,

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb. per gallon.	Purity.	Sucrose in juice.	
	Tons per acre.	Per cent. of mean.				lb. per acre.	Tons per acre.
B.2935	39·62	111·2	63·0	1·838	89·8	9,520	4·25
P.O.J.2878	37·25	104·5	56·6	1·922	89·9	8,410	3·75
G.119	36·25	101·6	59·2	1·686	88·8	7,550	3·37
B.726	33·37	93·7	57·9	2·039	91·8	8,130	3·63
S.C.12.4	31·70	89·0	57·0	1·905	90·8	7,140	3·19
Mean	35·63	100·0	58·7	1·878	90·2	8,150	3·64

The data in the above table are the means of 10 plots or analyses.

The standard error of the difference between any two mean yields is 1·20 tons cane per acre and a difference of 2·48 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE III

Variety Trial, College Estate

PLANT CANES (LATE REAPING)

Planted : November 25 to 27, 1933.
Reaped : May 9 to 13, 1935.
Manurial treatment : 25 tons pen manure per acre and 3 cwts. sulphate of ammonia per acre, 1 cwt. early and 2 cwts. late.
System of replication : Two 5 × 5 Latin squares.
Area of each plot : $\frac{1}{30}$ acre weighed. Border rows discarded.
Soil : Sandy loam.

Rainfall :	November and December 1933	15·05 in.
	January to December 1934	48·36 ,,
	January to April 1935	8·00 ,,
	Total	71·41 ,,

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb. per gallon.	Purity.	Sucrose in juice.	
	Tons per acre.	Per cent. of mean.				lb. per acre.	Tons per acre.
P.O.J.2878	38·99	123·3	56·0	2·053	88·9	9,240	4·13
B.2935	33·29	105·2	60·1	1·963	88·3	8,110	3·62
B.726	30·00	94·9	56·2	2·320	92·1	8,000	3·57
S.C.12.4	29·63	93·7	54·8	2·093	90·5	7,000	3·13
G.119	26·20	82·9	58·4	1·856	87·5	5,890	2·63
Mean	31·62	100·0	57·1	2·057	89·5	7,650	3·42

The data in the above table are the means of 10 plots or analyses.

The standard error of the difference between any two mean yields is 1·55 tons cane per acre and a difference of 3·20 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE IV

Variety Trial, Molineux Estate

PLANT CANES

Planted : November 2, 1933.
Reaped : February 25 and 26, 1935.
Manurial treatment : 25 tons pen manure per acre before planting and 1 cwt. sulphate of ammonia on January 30, 1934, and 2 cwts. sulphate of ammonia on May 23, 1934.

System of replication: Two 4 × 4 Latin squares.
Area of each plot: $\frac{1}{30}$ acre weighed. Border rows discarded.
Soil: Sandy loam.

Rainfall:	November and December 1933	19·51 in.
	January to December 1934	62·57 ,,
	January and February 1935	6·53 ,,
	Total	88·61 ,,

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb. per gallon.	Purity.	Sucrose in juice.	
	Tons per acre.	Per cent. of mean.				lb. per acre.	Tons per acre.
B.374	46·23	105·4	59·6	1·762	90·8	10,110	4·51
B.H.10.12	44·67	101·8	60·8	1·860	92·3	10,550	4·71
P.O.J.2878	44·27	100·9	61·0	1·834	90·2	10,310	4·60
B.726	40·31	91·9	61·9	2·004	95·0	10,440	4·64
Mean	43·87	100·0	60·8	1·865	92·1	10,340	4·62

The data in the above table are the means of 8 plots or analyses.

The standard error of the difference between any two mean yields is 1·20 tons cane per acre and a difference of 2·61 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE V

Variety Trial, Belmont Estate

Plant Canes

Planted: November 14, 1933.
Reaped: April 1 to 2, 1935.
Manurial treatment: An application of pen manure had been given to the previous ratoon crop on the experimental field. One cwt. of sulphate of ammonia per acre was applied on March 22, 1934, and 2 cwts. on May 25, 1934.
System of replication: Two 4 × 4 Latin squares.
Area of each plot: $\frac{1}{30}$ acre weighed. Border rows discarded.
Soil: Silty loam.

Rainfall:	November and December 1933	22·55 in.
	January to December 1934	73·14 ,,
	January to March 1935	6·15 ,,
	Total	101·84 ,,

Variety.	Cane.		Extraction, per cent.	Sucrose in juice, lb. per gallon.	Purity.	Sucrose in juice.	
	Tons per acre.	Per cent. of mean.				lb. per acre.	Tons per acre.
B.H.10.12	49·99	111·8	59·7	1·967	90·1	12,150	5·42
B.726	47·21	105·6	60·3	2·122	91·7	12,450	5·56
B.374	45·42	101·6	57·3	1·950	90·2	10,560	4·71
P.O.J.2878	36·17	81·0	58·4	1·923	87·4	8,430	3·76
Mean	44·70	100·0	58·9	1·991	89·9	10,900	4·86

The data in the above table are the means of 8 plots or analyses.

The standard error of the difference between any two mean yields is 1·65 tons cane per acre and a difference of 3·60 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE VI

Experiment to Ascertain the Effect on Yield of Plant Canes of Pen Manure used in Combination with Sulphate of Ammonia

Station : Buckleys Estate.
System of replication : Two 5 × 5 Latin squares.
Area of each plot : $\frac{1}{20}$ acre weighed. Four border rows discarded.
Soil : Sandy loam.
Treatments :

1. Pen manure. Usual dressing for the island, approximately 25 tons per acre, applied under the banks before planting.
2. Additional treatment 2 cwts. sulphate of ammonia per acre towards the end of the dry season.
3. Additional treatment 3 cwts. sulphate of ammonia per acre towards the end of the dry season.
4. Additional treatment 1 cwt. sulphate of ammonia per acre six to eight weeks after planting and 2 cwts. per acre towards the end of the dry season.
5. Additional treatment 1 cwt. sulphate of ammonia per acre six to eight weeks after planting and 3 cwts. per acre towards the end of the dry season.

Planted : November 3 and 4, 1933.
Reaped : February 14 to 19, 1935.

Treatment No.	Treatment with sulphate of ammonia.			Yield in tons of cane per acre.	Per cent. of mean.	Increment, tons of cane.
	January 4.	May 17.	Total.			
1 . .	nil	nil	nil	30·70	95·1	—
2 . .	nil	2 cwts.	2 cwts.	33·98	105·3	3·28
3 . .	nil	3 cwts.	3 cwts.	33·66	104·3	2·96
4 . .	1 cwt.	2 cwts.	3 cwts.	31·68	98·2	0·98
5 . .	1 cwt.	3 cwts.	4 cwts.	31·33	97·1	0·60
Mean .	—	—	—	32·27	100·0	—

Each yield in the above table is the mean of 10 plots.

The standard error of the difference between any two mean yields is 0·68 tons cane per acre and a difference of 1·39 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE VII

Experiment to Determine the Effect on Yield of Plant Canes of Different Spacings between Plants in the Row

Station : Canada Estate (dry area).
System of replication : Four 3 × 3 Latin squares.
Area of each plot : $\frac{1}{20}$ acre weighed. Border rows discarded.
Variety : S.C.12.4.
Treatments :

1. Distance between banks 4½ ft. and between cross holes 2 ft.
2. Distance between banks 4½ ft. and between cross holes 3 ft.
3. Distance between banks 4½ ft. and between cross holes 4 ft.

Manurial treatment : All plots received a dressing of pen manure at the rate of about 25 tons per acre before planting, an early dressing of sulphate of ammonia at the rate of 1 cwt. per acre on March 5, 1934, and a dressing at the rate of 3 cwts. of sulphate of ammonia per acre on June 8, 1934.
Planted : December 6 to 7, 1933.
Reaped : March 5 to 8, 1935.

Treatment.	1.	2.	3.	Mean.
Tons of cane per acre .	31·79	34·37	36·14	34·10
Per cent. of mean .	93·2	100·8	106·0	100·0

Each yield in the above table is the mean of 12 plots.

The standard error of the difference between any two mean yields is 1·36 tons cane per acre and a difference of 3·13 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE VIII

Experiments to Determine the Effect on Yield of Plant Canes of Different Spacings between Plants in the Row

Station : Stapleton Estate.
System of replication : Three 3 × 3 Latin squares.
Area of each plot : $\frac{1}{40}$ acre weighed. Border rows discarded.
Variety : B.H.10.12.
Treatments :

1. Distance between banks 4½ ft. and between cross holes 2 ft.
2. Distance between banks 4½ ft. and between cross holes 3 ft.
3. Distance between banks 4½ ft. and between cross holes 4 ft.

Manurial treatment : All plots received a dressing of pen manure at the rate of about 25 tons per acre before planting, an early dressing of sulphate of ammonia at the rate of 2 cwts. per acre on February 23, 1934, and a dressing at the rate of 3 cwts. of sulphate of ammonia per acre on May 30, 1934.
Planted : January 16, 1934.
Reaped : May 2 to 3, 1935.

Treatment.	1.	2.	3.	Mean.
Tons of cane per acre .	37·62	38·57	38·35	38·18
Per cent. of mean .	98·5	101·0	100·5	100·0

Each yield in the above table is the mean of 9 plots.

TABLE IX

Experiment to Determine the Effect on Yield of Plant Canes of a Megass Mulch

Station : West Farm Estate.
System of replication : Two 5 × 5 Latin squares.
Area of each plot : $\frac{1}{40}$ acre weighed. Border rows discarded.
Variety : S.C.12.4.
Treatments :

1. No megass.
2. 2-in. layer of megass on every other bank.
3. 2-in. layer of megass on every bank.
4. 3-in. layer of megass on every other bank.
5. 3-in. layer of megass on every bank.

Other treatments : Unmulched banks were farmed and cultivated according to general practice.
Manurial treatments : All plots received a standard dressing of pen manure. Plots 1, 2, 3 and 4 each received 1 cwt. sulphate of ammonia per acre on January 9, 1934, and another cwt. on February 16, 1934. On May 23, 1934, these plots received another 3 cwts. sulphate of ammonia per acre, and plot 5, 2 cwts.
Planted : November 17 to 18, 1933.
Megass applied : February 19 to 23, 1934.
Reaped : March 18 to 21, 1935.

Treatments.	1.	2.	3.	4.	5.	Mean.
Tons of cane per acre .	25·34	25·12	26·74	26·51	27·04	26·15
Per cent. of mean .	96·9	96·0	102·3	101·4	103·4	100·0
Increment, tons of cane	—	(— 0·22)	1·40	1·17	1·70	—

Each yield in the above table is the mean of 10 plots.

The standard error of the difference between any two mean yields is 0·73 tons cane per acre and a difference of 1·51 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE X

Experiment to Determine the Effect on Yield of Plant Canes of a Megass Mulch

Station : College Estate.
System of replication : Two 5 × 5 Latin squares.
Area of each plot : $\frac{1}{20}$ acre weighed. Border rows discarded.
Variety : S.C.12.4.
Treatments :

1. No megass.
2. 2-in. layer of megass on every other bank.
3. 2-in. layer of megass on every bank.
4. 3-in. layer of megass on every other bank.
5. 3-in. layer of megass on every bank.

Other treatments : Unmulched banks were farmed and cultivated according to general practice.
Manurial treatments : All plots received a standard dressing of pen manure. Plots 1, 2, 3 and 4 each received 2 cwts. sulphate of ammonia per acre on April 18, 1934, and 3 cwts. sulphate of ammonia on June 19, 1934. Plot 5 had only 2 cwts. sulphate of ammonia per acre applied on June 19, 1934.
Planted : February 20, 1934.
Megass applied : February 27 to March 5, 1934.
Reaped : May 14 to 17, 1935.

Treatments.	1.	2.	3.	4.	5.	Mean.
Tons of cane per acre .	29·53	30·69	32·14	30·10	32·11	30·91
Per cent. of mean . .	95·5	99·3	104·0	97·3	103·9	100·0
Increment, tons of cane .	—	1·16	2·61	0·57	2·58	—

Each yield in the above table is the mean of 10 plots.

The standard error of the difference between any two mean yields is 0·86 tons cane per acre and a difference of 1·78 tons per acre may be regarded as significant with a 20 : 1 probability.

TABLE XI

Manurial Treatment of Un-pen-manured Upper Land

Station : Hope Estate.
System of replication : One 6 × 6 Latin square.
Area of each plot : $\frac{1}{20}$ acre weighed. Border rows discarded.
Variety : B.H.10.12.
Treatments per acre :

1. 2 cwts. sulphate of ammonia towards end of dry season, 1934.
2. 3 cwts. sulphate of ammonia towards end of dry season, 1934.
3. 2 cwts. sulphate of ammonia 6–8 weeks after planting and 2 cwts. towards end of dry season 1934.

4. 2 cwts. sulphate of ammonia and 1½ cwt. muriate of potash 6–8 weeks after planting; 2 cwts. sulphate of ammonia towards end of dry season 1934.
5. 2 cwts. sulphate of ammonia 6–8 weeks after planting and 3 cwts. sulphate of ammonia towards end of dry season 1934.
6. 2 cwts. sulphate of ammonia and 1½ cwt. muriate of potash 6–8 weeks after planting; 3 cwts. sulphate of ammonia towards end of dry season 1934.

Planted: February 6 to 7, 1934.
Reaped: March 25 to 29, 1935.

Treatment No.	Manurial treatment. Muriate of potash, April 3, 1934.	Sulphate of ammonia. April 3, 1934.	Sulphate of ammonia. June 21, 1934.	Total.	Yield in tons of cane per acre.	Per cent. of mean.	Increment, tons of cane.
1 .	nil	nil	2 cwts.	2 cwts. sulphate of ammonia	28·98	82·8	—
2 .	nil	nil	3 cwts.	3 cwts. sulphate of ammonia	32·59	93·1	3·61
3 .	nil	2 cwts.	2 cwts.	4 cwts. sulphate of ammonia	35·65	101·9	6·67
4 .	1½ cwts.	2 cwts.	2 cwts.	4 cwts. sulphate of ammonia and 1½ cwts. muriate of potash	38·16	109·1	9·18
5 .	nil	2 cwts.	3 cwts.	5 cwts. sulphate of ammonia	35·36	101·1	6·40
6 .	1½ cwts.	2 cwts.	3 cwts.	5 cwts. sulphate of ammonia and 1½ cwts. muriate of potash	39·18	112·0	10·20
Mean	—	—	—	—	34·99	100·0	—

Each yield in the above table is the mean of 6 plots.
The standard error of the difference between any two mean yields is 1·56 tons cane per acre and a difference of 3·25 tons may be regarded as significant with a 20 : 1 probability.

Root Crops

Cocoyams

Gold Coast.—According to the report of the Acting Director of Agriculture for the period January–June 1935 no definite solution to the problem of control of the cocoyam root rot has yet been found, though from district reports it would appear that its incidence is not so high as formerly. Trials with other salts having failed, the effect of nitrates added to the soil was tried, laboratory experiments having shown that the absence of nitrates alone favours infection by *Rhizoctonia Solani.* In practice this treatment failed. It was also found that turning in leguminous green cover crops, notably *Calopogonium,* had a rapid beneficial effect, which was, however, only a temporary tonic. Soil dis-

infection, with newly produced cheap compounds which would be economically practicable, is now being tried.

Fruits

Bananas

Gold Coast.—The Acting Director of Agriculture in his report on investigations conducted during the period January–June 1935 states that an experiment with bananas, using artificial manures against (1) control and (2) mulching with weeds, has been in progress for a year at Asuansi Station. Basic slag has been applied at the rate of 10 cwts. per acre, and lime and sulphate of potash at 5 cwts. per acre each. In the first year, basic slag and plain mulching have given the best results, lime and sulphate of potash appearing to have little (if not an adverse) effect. The increase in yield obtained from the use of basic slag is insufficient, however, to cover the cost.

Citrus

Leeward Islands.—*Dominica.*—The report by Mr. F. G. Harcourt, Agricultural Superintendent, Dominica, for the half-year January–June 1935 contains the following statement relating to the work conducted on citrus fruits, in continuation of previous reports.

1. *Lime Breeding.*—Of the original hybrids, only 113 have been selected and retained for further experiment, all which were not vigorous or highly resistant to withertip disease being discarded, as well as those which were wholly unsuitable in fruiting characters.

The progeny obtained from the back-crossing of the F_1 generation in 1931 were grafted on to sour orange or rough lemon stocks and 186 hybrids of the second generation were planted in the trial grounds. The more promising are to be again back-crossed with the West Indian lime.

2. *Stock Trials for Limes.*—In the triplicate series of trials of root-stocks for limes, the trees on grapefruit stock continue to make slightly better progress as regards both yield and growth increments than do the trees on sour orange or rough lemon stocks.

3. *Grapefruit and Oranges, Variety and Stock Trial.*—The trees are young and there is no useful information to give.

4. *Government Fruit Farm.*—The work outlined in previous reports has been continued and the young citrus trees are making good growth. Extended use is made of leguminous plants as cover crops, chiefly *Tephrosia candida* and *Cajanus indicus* (pigeon pea). Stress is laid on the

advantage of using these two legumes, for not only do they function as cover crops, but on account of their habit and comparatively long period of growth, they serve as temporary light wind-breaks or shelter crops.

5. *Plant Distribution.*—The propagation of budded citrus for general distribution to estates in Dominica has been continued on a fairly large scale. Prolonged dry weather has prevented planting operations in the greater part of the island, but large stocks of strong healthy plants are on hand to meet demands as soon as the dry weather breaks. Plants distributed during the first half of the year 1935 include: 105 grapefruit, 263 limes and 61 oranges.

6. *Demonstration Plots, Experiment Station.*—In addition to the above-mentioned root-stock trials and the top-working of lime trees referred to below, plots of limes are established in this Station to demonstrate to growers the value of proper cultural methods.

7. *Top-working Lime Trees.*—The trial of various methods of top-working lime trees with grapefruit was outlined in a previous report (this BULLETIN, 1934, **32**, 146). Nineteen of the thirty-four trees operated on had made satisfactory growth and averaged 5 ft. 3 in. in height. Nine trees died and the remainder have made but poor development. The high proportion of failures is to some extent attributed to the abnormally dry weather experienced. So far, there is no evidence of incompatibility between the lime and grapefruit. The simplest and most successful method of top-working appears to be that of cutting back the lime tree to about 18 in. from the ground and budding the resulting new lime shoots.

OIL SEEDS

Coconut

Gold Coast.—The Acting Director of Agriculture reports that the increasing use of copra for production of coconut oil is a feature in the Eastern Province of the Gold Coast. The oil is largely used for soap-making as well as for domestic use. Some idea of the volume of the local trade in this product is given by the fact that in the first three months of 1935 one native market, at Keta, dealt with 26,000 gallons of native-produced oil.

FIBRES

Cotton

Uganda.—The following statement relating to cotton experiments conducted at the Bukalasa Experiment

Station during the period January–June 1935 has been furnished by the Director of Agriculture.

Breeding Work.—In the B.P.50 (ex-Buganda Local) group some uniformity in staple was gained, but there was no other marked advance in character; the members of the group are still irregular in their susceptibility to black arm disease. The S.G.23/8 (ex-Nyasaland Upland) group has not so far produced a satisfactory combination of long staple and high ginning out-turn; a slight improvement over the original parent in the matter of black arm is recorded. Another pedigree, B.P.89 (ex-Buganda Local), gives a high yield in spite of marked susceptibility to black arm, and has good lint characters. The U4/4/2 group (ex-Barberton via Serere) yielded very well, but has unsatisfactory staple character.

Hybridisation was begun and yielded eleven F_1 lines, and work on resistance to Fusarium wilt was continued.

A variety trial gave the following results, the yields of seed-cotton and lint being expressed as percentages of the control variety.

Variety.	Origin.	Black arm lesions per plant.	Seed-cotton.	Ginning out-turn.	Lint.	Lint length.
						mm.
B.P.58 . .	S.G.23/8	3·95	103·7	30·0	102·3	—
B.P.50 . .	B.37 ex-Local	3·90	100·5	30·7	101·5	31·0
Buganda Local	—	2·71	100·0	30·4	100·0	27·6
B.P.59 . .	S.G.23/8	3·54	97·6	28·5	91·6	29·9
B.P.52 . .	B.42 ex-Local	6·48	96·7	29·9	95·1	31·5
S.G.23/8 .	Nyasaland Upld.	3·87	92·2	31·6	95·9	29·4
B.P.56 . .	B.45 ex-Local	3·48	85·5	30·7	86·4	—
B.P.49 . .	B.31 ex-Local	5·40	60·9	29·6	59·3	—
Least significant difference		1·04	8·7	—	8·7	—

Spinning tests were carried out by the British Cotton Industry Research Association and the Indian Central Cotton Committee. S.G. 23/8 was again outstanding in spinning performance, although it is always marked down by brokers.

Cultural Experiments.—The results of the various trials were as follows:

(*a*) *Tractor v. Native Cultivation and Spacing Trial.*—The two cultivations gave yields which were not significantly different, but 3 × 1 ft. spacing gave better yields than the standard 4 × 1½ ft. spacing. These results confirm those of the previous year.

(*b*) *Topping Experiment.*—Plants topped at flowering time gave yields not significantly more than those of the controls.

(c) *Two and One Plants per Hole Experiment.*—The native method of leaving two plants per hole yielded apparently better, but not significantly better, than the plantation method of leaving one plant per hole.

(d) *Interplanting Experiment* (cotton with ground-nuts or beans).—A greater cash return was obtained by interplanting as in the previous year, and interplanting actually increased the yield of cotton per acre, as follows: Cotton (– Beans) > Cotton (– Ground-nuts) > Cotton (alone).

(e) *Mulching Experiment.*—Mulching with elephant grass to a depth of 3 in. (as opposed to 6 in. in the previous year) still increased the yield of cotton, and the net return after deducting the cost of mulching is now greater than from the control plots.

(f) *Green Manure Experiment.*—An experiment designed to show differences in effect between different "times of digging-in" green manure (*Crotalaria juncea*) before cotton gave interesting results as follows:

Period between digging-in and planting cotton.	Yield of seed-cotton (percentage of control).
Control	100·0
2 weeks	94·8
4 weeks	114·9
6 weeks	105·1
8 weeks	99·8
Least significant difference	11·3

(g) *Manurial Experiment.*—An experiment to test the residual effect of rotted cotton seed and green manure and a combination of the two on a ground-nut—cotton rotation was carried through another cycle; the residual effect was significant in the ground-nut crop but not in the cotton crop following. The results given below are expressed as percentages of the control.

	Yields of unshelled ground-nuts.	Yields of seed-cotton.
Rotted cotton seed	131·2	117·9
Cotton seed and green manure	108·9	112·8
Green manure (*C. juncea*)	98·2	104·1
Control	100·0	100·0
Least significant difference	14·7	—

MINERAL RESOURCES

UGANDA

The Imperial Institute has received the following statement from the Director of the Geological Survey regarding the work carried out during the six months ended June 30, 1935.

With the return of the Director and of Mr. A. D. Combe from leave, the transfer of Mr. C. B. Bisset from

Nyasaland, and the appointment of Mr. H. J. R. Way, greater activity in field work was possible during the first half of 1935.

Visits have been made to numerous areas where prospectors were opening up alluvial gold deposits and cassiterite veins. The exports of tin ore showed an increase, but during the first part of the year the amount of gold exported has not reached the figure for the first six months of 1934, as the areas held are mostly under prospecting licences and work is being done rather to prove the extent of the deposits than to win gold.

The Lubare area in Igara in western Ankole (this BULLETIN, 1935, **33**, 81), where gold had been previously discovered, is being intensively prospected by the holders of an Exclusive Prospecting Licence, and Mr. A. D. Combe has made a geological survey of the area. According to reports published by the company holding the licence, the area offers good prospects of an alluvial field and every effort is being made to locate the reefs. Both in Ankole and in Kigezi the gold-bearing veins have proved elusive and the only promising reef showing good assay values so far located is in northern Ankole. Gold presents one of the most interesting problems of mineral occurrence in Uganda. In alluvial deposits it is commonly found coarse, near its source, and is sometimes well crystallised. Some observers believe that the gold has been secondarily crystallised in the alluvial deposits, but this remains to be proved. Fragments of vein quartz containing crystals of gold similar to those occurring in the alluvium have been found in a stream bed in Buhwezu county of northern Ankole.

In Kigezi, most of the gold is found in stream deposits which lie round an outcrop of granite (Ruhuhuma granite), and in one alluvial gold area a little north of Kabale, where vein-quartz pebbles in the gravel are rare, the association of the gold with pyrite, wolfram, rutile, monazite, zircon, cassiterite and native copper suggests that pegmatite veins should be sought. This interesting area is now being closely prospected.

No new deposits of cassiterite have been located during the period under review, but much work has been done in opening up the known veins.

One new locality for columbite-tantalite has been discovered.

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Forestry in British Guiana. Supplementary Statement prepared by the Forest Department for presentation to the Fourth British Empire Forestry Conference, South Africa, 1935. *Legislative Council Paper No.* 8, 1935, *B. Guiana.* Pp. 11, 13 × 8½. (Georgetown: Government Printer, 1935.)

Administration Report of the Acting Conservator of Forests, Ceylon, for 1934. Pp. 18, 9¾ × 6¼. (Colombo: Government Record Office, 1935.) Price 20 cents.

Annual Report of the Forest Administration in Cyprus for the year 1934. By A. H. Unwin. Pp. 66, 9 × 6. (Nicosia: Government Printer, 1935.)

Report on Forest Administration, Federated Malay States, for the year 1934. Pp. 81, 9¾ × 6. (Kuala Lumpur: Government Printer, 1935.)

Report on the Forestry Department, Gold Coast, for the year 1934–35. Pp. 12, 13 × 8¼. (Accra: Government Printing Department, 1935.) Price 1*s*.

Annual Report on the Forest Department, Mauritius, for the year 1934. Pp. 17, 9¾ × 6¼. (Port Louis: Government Printer, 1935.)

Annual Report of the Director of Forestry, New Zealand, for the year ended March 31, 1935. Pp. 19, 13¼ × 8¼. (Wellington: Government Printer, 1935.)

Annual Report of the Forest Department, North Borneo, for the year 1934. Pp. 22, 13 × 8¼. (Jesselton, N. Borneo: Government Printing Office, 1935.) Price $1 or 2*s*. 4*d*.

Annual Report of the Forest Department, Sierra Leone, for the year 1934. Pp. 11, 13 × 8. (Freetown: Government Printer, 1935.) Price 1*s*.

The Fourteenth Annual Report of the Forest Department, Tanganyika Territory, 1934. Pp. 19, 13¼ × 8¼. (Dar es Salaam: Government Printer, 1935.) Price Sh. 1/-.

Administration Report of the Conservator of Forests, Trinidad and Tobago, for the year 1934. Pp. 20, 13¼ × 8¼. (Port of Spain: Government Printer, 1935.)

The Group Method of Natural Regeneration on the Rain Forest at Sapoba, Southern Nigeria. By J. D. Kennedy. *Empire For. Journ.* (1935, **14**, 19–24).

Herbebossching met Dennen ter Oostkust van Sumatra. By P. C. M. Fluyt. *Tectona* (1935, **28**, 633–699). With English summary. Deals with reafforestation with pine on the east coast of Sumatra.

Forest Improvement Measures for the Southern Appalachians. *Tech. Bull. No.* 476, *U.S. Dept. Agric.* Pp. 45, 9 × 6. (Washington, D.C.: Superintendent of Documents, Government Printing Office, 1935.) Price 5 cents.

Ecological Problems of the Humus Layer in the Forest. By L. G. Romell. *Mem.* 170, *Cornell Univ. Agric. Exper. Sta.* Pp. 26, 9 × 6. (Ithaca, New York: Cornell University, 1935.)

The Influence of the Growing Uses of Substitutes for Timber upon Forest Policy with Special Reference to Burma. By S. F. Hopwood. *Indian Forester* (1935, **61**, 558–572).

Timbers

Report on Work of the Division of Forest Products, Council for Scientific and Industrial Research, Australia, for the year 1934–35. Pp. 29, 13¼ × 8¼. (Canberra: Council for Scientific and Industrial Research, 1935.) Mimeographed copy.

Programme of Work of the Division of Forest Products, Council for

Scientific and Industrial Research, Australia, for the year 1935–36. Pp. 33, 10×8. (Canberra: Council for Scientific and Industrial Research, 1935.) Mimeographed copy.

Timber Supply, Consumption and Marketing in Western Australia. Statement Prepared for the Fourth British Empire Forestry Conference, South Africa, 1935. Pp. 13, 13×8. (Perth: Government Printer, 1935.)

The Testing of Timbers at the Forest Products Research Laboratory. *Forest Prod. Res. Rec. No.* 1, *Dept. Sci. Indust. Res.* Pp. 8, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1935.) Price 6*d.*

Timber Supply Consumption and Marketing in British Guiana. Special Statement Prepared for Presentation to the Fourth British Empire Forestry Conference, South Africa, 1935. Pp. 14, $13\frac{1}{4} \times 8\frac{1}{2}$. (Georgetown, Demerara: Government Printer, 1935.)

Official List of Trade Names of Indian Timbers. *Forest Bull. No.* 90 (*Econ. Series*), *Forest Res. Inst., Dehra Dun.* Pp. 11, $9\frac{3}{4} \times 7\frac{1}{2}$. (Delhi: Manager of Publications, 1935.) Price As. 4 or 5*d.*

Timber Uses. By B. S. Mee and D. S. P. Noakes. *Malayan Forester* (1935, **4**, 138–141). An account of possible uses of various Malayan timbers.

Experiments on the Preservation of Mine Timber. Progress Report No. 1. By J. Bryan and N. A. Richardson. *Forest Prod. Res. Rec. No.* 3, *Dept. Sci. Indust. Res.* Pp. 10, $9\frac{1}{2} \times 6$. (London: H.M. Stationery Office, 1935.) Price 6*d.* See abstract, page 474.

The Selection, Preservation, Distribution and Identification of Australian Pole Timbers. By J. E. Cummins and H. E. Dadswell. *Pamphlet No.* 55, *Div. Forest Products, Counc. Sci. and Indust. Res., Australia.* Pp. 79, $9\frac{1}{2} \times 6$. (Melbourne: Council for Scientific and Industrial Research, 1935.)

Home Grown Timbers, their Anatomical Structure and Its Relation to Physical Properties: Ash. *Progress Rept. No.* 3, *Project* 18, *For. Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 19, $9\frac{1}{2} \times 7\frac{1}{2}$. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1935.) Mimeographed copy.

Tests on Timbers from the State of North Borneo. Tests on Urat Mata (*Parashorea* sp.) and Belian (*Eusideroxylon zwageri*) in a Green Condition. *Malayan Forester* (1935, **4**, 131–134).

The Properties and Uses of Kauri (*Agathis australis*). By A. R. Entrican. *Leaflet No.* 26, *New Zealand State Forest Service.* Pp. 14, 9×6. (Wellington: Government Printer, 1935.)

Cedrela in the Malay Peninsula. By C. F. Symington. *Malayan Forester* (1935, **4**, 119–126). Gives a description of *Cedrela* spp., characteristics and economic possibilities.

Investigation of the Efficacy of End Treatment in the Prevention of Stain in Ohia (*Celtis Soyauxii* Engl.) from Nigeria and the Possibility of Using the Timber as a Substitute for Ash. *Investigation No.* 11, *Project* 23, *Forest Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 12, $9\frac{1}{2} \times 7\frac{1}{2}$. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1935.) Mimeographed copy.

Properties of Coachwood (*Ceratopetalum apetalum* D. Don), Australia. *Investigation* 14, *Project* 22, *Forest Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 4, $9\frac{1}{2} \times 7\frac{1}{2}$. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1935.) Mimeographed copy.

Tests on Small Clear Specimens of Green Karri (*Eucalyptus diversicolor*). By I. Langlands. *Journ. Counc. Sci. Indust. Res., Australia* (1935, **8**, 228–230).

Notes on Insect Attack on Mora (*Mora excelsa* Benth.) in Trinidad. *Leaflet No.* 6, *Forest Dept., Trinidad and Tobago.* Pp. 39, $8\frac{1}{2} \times 5\frac{1}{2}$. (Port of Spain: Government Printer, 1935.) Price 6*d.*

Properties of Purpleheart (*Peltogyne ? pubescens* Benth.); British Guiana. *Investigation 11, Project 22, Forest Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 6, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1935.) Mimeographed copy.

Properties of Banak (*Virola merendonis* Pittier) from British Honduras. *Investigation 5, Project 24, Forest Prod. Res. Lab., Dept. Sci. Indust. Res.* Pp. 38, 9½ × 7½. (Princes Risborough, Bucks: Forest Products Research Laboratory, 1935.) Mimeographed copy.

Strength Tests of Structural Timbers. Part I. General Principles with Data on Redwood from Gefle and Archangel. *Forest Prod. Res. Rec. No. 2, Dept. Sci. Indust. Res.* Pp. 10, 9½ × 6. (London: H.M. Stationery Office, 1935.) Price 6*d.*

The Pinhole Borer of North Queensland Cabinet Woods. By J. H. Smith. *Queensland Agric. Journ.* (1935, **43**, 445–451; 532–548; **44**, 9–14; 145–153).

Fungi Causing Stain in Logs and Lumber in the Southern States, including Five New Species. By R. W. Davidson. *Journ. Agric. Res.* (1935, **50**, 789–807).

The Chemistry of Wood. *Trade Circ. No. 28, Div. For. Prod., Counc. Sci. Indust. Res., Australia.* Pp. 10, 9¼ × 6. (Melbourne: Government Printer, 1935.)

Gums and Resins

The Purification and Standardization of Kauri Gum. By J. R. Hocking. *New Zealand Journ. Sci. and Tech.* (1935, **17**, 369–387). Also discusses the uses of the gum and the possibilities of the industry.

Direct Liquid Extraction Process for Pure Lac Resin. By L. C. Verman and R. Bhattacharya. *Tech. Paper No. 5, London Shellac Res. Bureau.* Pp. 30, 8½ × 5½. (London: India House, 1935.)

Fundamental Physical Properties of Lac. Part I. Mechanical Properties. By L. C. Verman. *Tech. Paper No. 3, London Shellac Res. Bureau.* Pp. 28, 8½ × 5½. (London: India House, 1935.)

Fundamental Physical Properties of Lac. Part II. Thermal Properties. By L. C. Verman. *Tech. Paper No. 4, London Shellac Res. Bureau.* Pp. 20, 8½ × 5½. (London: India House, 1935.)

Tanning Materials

The Tannin Content of a Variety of *Acacia mollissima* Willd. By F. A. Coombs, W. McGlynn and M. B. Welch. *Journ. and Proc. Roy. Soc. N.S. Wales* (1934, **48**, 246–248).

Il legno di Tizera della Sicilia. By G. A. Bravo. *Boll. Uff. R. Staz. Sper. per l'Indust. dell Pelli e delle Materie Conciante* (1935, **13**, 180–185). An account of the tanning bark from "Tizera" (*Rhus pentaphylla*).

Die Türkische Valonea—Extraktindustrie. By L. Seligsberger. *Gerber* (1935, **61**, 60–61).

The Flaying and Curing of Hides. *Journ. Dept. Agric., Victoria* (1935, **33**, 313–325, 351).

Research on the Processing of New Zealand Pelts. By D. J. Lloyd and P. White. *Journ. Fed. Curriers, Light Leather Tanners and Dressers, Inc.* (1935, **16**, 234–238).

Dyestuffs

Annato-Zaad. By D. R. Koolhaas and C. van de Koppel. *Indische Mercuur* (1935, **58**, 525–527). An account of the trade in annatto.

NOTICES OF RECENT LITERATURE

Books for review should be addressed to "The Editor," Bulletin of the Imperial Institute, South Kensington, London, S.W.7.

A DICTIONARY OF THE ECONOMIC PRODUCTS OF THE MALAY PENINSULA. By I. H. Burkill, M.A., F.L.S., with contributions by William Birtwistle, Frederick W. Foxworthy, Ph.D., J. B. Scrivenor, I.S.O., M.A., F.G.S., and J. G. Watson. Pp. xi + 2402, 9 × 6, in two volumes. (London: Crown Agents for the Colonies, 1935.) Price 30*s*.

The idea of preparing a dictionary of economic Malayan plants arose out of an index which Mr. Burkill prepared from official and other records whilst Director of Gardens in the Straits Settlements during the period 1912–25. The project received the approval of the Government of the Straits Settlements and Federated Malay States, and arrangements were made for the work to be carried out after Mr. Burkill's retirement from the colonial service. The scope of the work was extended to include animal and mineral products, as well as those of vegetable origin, and the assistance was enlisted of the heads of the Fishery, Forestry and Geological Departments in Malaya, whose names appear on the title-page. Nearly three years were spent in the preparatory work of collecting references, and the Imperial Institute can bear witness to the thoroughness with which Mr. Burkill prosecuted this task. Every publication in the Institute's library likely to yield information having any bearing on Malayan products was gone through minutely and other libraries were similarly searched. The results are on record in the original index slips, nearly 50,000 in number, which Mr. Burkill, with the concurrence of the Government of the Straits Settlements, has deposited at the Imperial Institute for reference purposes. The work of writing the book, 94 per cent. of which fell to Mr. Burkill, and the editing, have occupied the remaining seven years.

The volumes will take an honoured place beside Watt's *Dictionary of the Economic Products of India*. Like that classic, the arrangement of the articles is strictly alphabetical; those on plant and animal products are to be found under the accepted Latin generic names, and in only a few instances, such as domestic and other familiar animals, is this arrangement departed from. The minerals are given under the names used in the standard textbooks. A few products of multiple origin, like dammar and rattans, are the subject of collective articles, but the individual

products in such cases are dealt with under their botanical names also.

The adoption of the latest accepted botanical nomenclature has resulted in a few unfamiliar names appearing at the head of the article. For example, *Madhuca* for *Bassia* and *Pithecellobium* for *Pithecolobium*, but the insertion of cross-references where necessary avoids any difficulty on this score.

Lack of space has prevented the inclusion of botanical descriptions of the plants dealt with, and for these, in the case of the indigenous plants, the reader is referred to Ridley's *Flora of the Malay Peninsula*. The work, however, is not confined to the indigenous plants, and all introduced plants, whether grown as crops or merely as specimens in the Botanic Gardens, are included.

From the nature of things the work is in the main a catalogue of the properties and uses of the products, an authority being quoted for almost every statement, but some of the longer articles—Cinchona, coconut, coffee and Hevea, among others—are prefaced by a most interesting and readable account of the history and distribution of the product. Special consideration has been given in regard to the native names. These include not only the Malay names, but also others likely to be employed in the Peninsula by immigrants from Java, parts of Siam, etc. These names form the bulk of the carefully prepared index.

Everyone concerned with this monumental work is to be congratulated—Mr. Burkill for his industry in collecting and skill in presenting such a mass of information, the Malayan Governments for the financial backing which has enabled the book to be issued at such a low price and the Oxford University Press, the printers, for the exceptionally clear type and setting.

Agriculture in Southern Africa. By Clifford C. Taylor. *Technical Bulletin No. 466, United States Department of Agriculture.* Pp. 341, $9\frac{1}{4} \times 6$. (Washington, D.C.: Superintendent of Documents, 1935.) Price 30 cents.

This is a detailed economic study of the agricultural position in that part of Africa lying south and east of the Belgian Congo. The area covered thus includes all the Central and East African Colonies, Rhodesia and the Union of South Africa, as well as the Portuguese territories of Angola and Mozambique. After a general description of the countries concerned, a detailed account of the most important commodities is given. These include wool and mohair; cattle and other livestock; fruits, both fresh and

dried; tobacco; cotton; sugar; maize; wheat and other cereals. Particulars are given of the trend of production and trade in each country; methods of marketing; prices; Government assistance, if any, and such-like matters. Sketch-maps are given showing the distribution of the products in the various countries and there are numerous charts and statistical tables.

As the author points out, "a general recognition throughout the world of the mutual gains to be derived from a broader knowledge of the present and probable future production of farm products in other countries will contribute greatly toward enhancing general well-being." Mr. Taylor's publication is a valuable contribution toward that end.

His conclusions as to the trend of agricultural developments in southern Africa are of interest. He sees in the future a decrease in the production of wool, mohair and exportable maize; an increase in the production of cattle, citrus fruit and sugar; and a probable increase in the production of cotton and tobacco, especially by natives in countries south of the Equator, with the exception of the Union of South Africa.

A Short History of the Gold Coast. By W. E. Ward, M.A., B.Litt. Pp. ix + 241, $7\frac{1}{4} \times 4\frac{3}{4}$. (London: Longmans, Green & Co., 1935.) Price 3*s.* 6*d.*

The author of this instructive book is Senior History Master in the Prince of Wales College, Achimota, and has written the work primarily for African pupils. In his own words, he has "tried to make it suitable for school use by keeping the English simple, and by looking as far as possible on African history from the African point of view." He points out that the name of the Gold Coast in its present sense is a modern application, but for the purpose of the history he has dealt with the entire territory now included under the name, and necessarily also the regions to the north of it which were in the past the scene of historical episodes having a direct bearing on later conditions in the Gold Coast itself.

Owing to the paucity of reliable information on the social history of the country, Mr. Ward has perforce confined his attention almost entirely to political history, tribal movements, wars and treaties, and the rise and fall of States. It is not possible here to describe the volume in detail, and it must suffice to say that it is a very interesting and well-written work which should appeal to the general reader interested in West Africa as well as to those for whom it is specially designed.

SWEET MANUFACTURE. A PRACTICAL HANDBOOK ON THE MANUFACTURE OF SUGAR CONFECTIONERY. By N. F. Scarborough, A.M.I.Mech.E. Pp. xi + 116, $8\frac{1}{2} \times 5\frac{1}{2}$. (London: Leonard Hill, Ltd., n.d.) Price 7*s*. 6*d*.

Dr. H. B. Cronshaw, the Editor of *Food Manufacture*, contributes a short preface to this book, in which he points out that its object is to give those engaged in the food industry, especially on a small scale, a clear and straightforward description of present-day manufacturing operations, and the nature of the plant and equipment employed; advanced technical or chemical knowledge on the part of the reader not being presumed. The author himself states that the work "does not profess to be a recipe book in any sense of the word, and the recipes given, although taken from current practice, are included as instances of types which, as any confectioner is aware, are the basis of countless variations and elaborations."

The subject-matter is clearly and concisely presented, and the book should be of great practical value to those for whom it is intended.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT. Volume II. Pp. xxxvi + 889, $6\frac{1}{2} \times 4$. Twentieth Edition. Published by direction of the Council of the Pharmaceutical Society of Great Britain. (London: The Pharmaceutical Press; and H. K. Lewis & Co., Ltd., 1935.) Price 22*s*. 6*d*.

This edition of Vol. II of the *Extra Pharmacopœia* commences a new chapter in the history of this well-known book of reference. The death of William Harrison Martindale in April 1933, together with the rapid expansion of the medical sciences in recent years and the vast increase in bulk of the scientific literature to be examined prohibited the continuance of the revision by one individual. In view of these circumstances, the Council of the Pharmaceutical Society of Great Britain decided to take over the responsibility of its continued production. The task of its revision was delegated by the Council to the British Pharmaceutical Codex Revision Committee, and Mr. C. E. Corfield was appointed editor. The two books, *Martindale* and the *Codex*, are therefore now under the same editorship and have become complementary.

The first volume of this edition (see this BULLETIN, 1932, **30**, 522) is devoted mainly to treatments with drugs and chemicals. The present volume, like the previous edition, is concerned with matters of diagnosis, analysis and assay of medicinal products, and with many other

subjects related to medicine, chemistry and pharmacy. A large proportion of the subject-matter has been completely rewritten, whilst by eliminating information of less direct value space has been found for accounts of modern medicinal substances. Amongst the sections which have been subjected to thorough revision in the light of recent advances may be mentioned those on hormones, nutrition, vitamins, methods of sterilisation and disinfectants. It is perhaps unfortunate that the new Schedule of Poisons (now under consideration) was not available to the Committee during the revision, and that in consequence it was not considered desirable to indicate which of the substances mentioned are poisons or come within Part I or Part II of the Schedule.

This edition, with its excellent index, will continue to be an indispensable reference book to those engaged in the professions of medicine, medical science and pharmacy.

A NAVAL STORES HANDBOOK DEALING WITH THE PRODUCTION OF PINE GUM OR OLEORESIN. Compiled by the Forest Service, the Bureau of Entomology and Plant Quarantine and the Bureau of Plant Industry. *Miscellaneous Publication No. 209, United States Department of Agriculture.* Pp. 201, $9\frac{1}{4} \times 6$. (Washington, D.C.: Superintendent of Documents, 1935.) Price 20 cents.

The main purpose of the compilers of this handbook was to supply information which would enable the resin producers of the South-eastern States to obtain more profitable returns from the forests, reduce forest waste and improve their product. The result of their work has been to provide everyone interested in the subject with a comprehensive account of this industry in the United States, with a briefer description of production in France, India and other countries.

The two chief sources of turpentine in the United States, the long-leaf pine (*Pinus palustris*) and the slash pine (*Pinus caribæa*), are described in full—their distribution, habits and growth, distinguishing characteristics and their value as sources of resin, lumber and paper pulp—and the other American resin-yielding pines are more briefly dealt with. An account is given of the nature of oleoresin and its occurrence in the tree, the latter including a detailed description of the internal structure of the tree and the changes which take place in the tissues as a result of tapping. Next follow long sections on the various methods of obtaining the oleoresin and the factors which influence yield. There is a useful discussion of forest management, and fire, grazing, insects, fungi and other

factors affecting forest production are also adequately dealt with.

The comprehensive character of the *Handbook* can be gauged by the fact that the list of "Literature Cited" comprises 581 entries. The numerous illustrations reach the high standard one has come to expect of the United States Department of Agriculture's publications and there is a welcome innovation in the provision of a full index.

FOREST TREES AND TIMBERS OF THE BRITISH EMPIRE. III. FIFTEEN SOUTH AFRICAN HIGH FOREST TIMBER TREES. By L. Chalk, M.A., D.Phil., M. M. Chattaway, B.Sc., M.A., J. Burtt Davy, M.A., Ph.D., F. S. Laughton, B.Sc. and M. H. Scott, B.Sc. Pp. 103, $9\frac{1}{2} \times 6$. (Oxford: The Clarendon Press; London: Humphrey Milford, Oxford University Press, 1935.) Price *7s. 6d.*

The appearance of a third Part of this series is welcome not only on account of the merits of the book, but as encouraging the belief that the series will not be closed before a volume of information adequate to the needs and possibilities of the subject has been made available. Parts I and II referred to in this BULLETIN (1932, **30**, 392; 1934, **32**, 183) dealt with the East African Coniferæ and Leguminosæ and West African timber trees, respectively. An account of South African high forest timber trees, as furnished in the Part now published, is specially acceptable since information on the useful timbers of South Africa and of the trees yielding them is not readily available outside the Union where the woods are of much more practical significance than might be supposed from their virtual absence from world commerce.

A notable feature of the book is the collaboration in authorship and the co-operation of the Forestry Department of the Union of South Africa. This has resulted in the selection of species for description being left in the hands of Mr. J. J. Kotzé, Chief of Forest Research, Pretoria, while Mr. F. S. Laughton, Forest Research Officer, Knysna, deals with natural regeneration and silviculture and Mr. M. H. Scott, of the Forest Products Division, Pretoria, contributes information concerning the utilisation and properties of the timbers. Botanical material has also been supplied by botanical and forestry authorities in South Africa.

The subject-matter falls into two sections. Mr. Laughton gives a short account of the distribution of the South African high forests and a description of the Knysna forests in which the tree species selected most abundantly occur. As is well known, the South African forests are

practically confined to a strip of country along the south and east coasts where relatively moist conditions prevail, and while formerly of very considerable extent are now much reduced by felling and by fire, the latter being the most potent agent. The body of the work, which is excellently illustrated, consists of descriptions of the selected species which (with additional reference to their timbers and local uses) are as follows: kamassi (*Gonioma kamassi* E. Mey.), the source of kamassi boxwood, a timber exported for use in making shuttles; assegai (*Curtisia faginea* Ait.), yielding a tough elastic wood in great demand for wheel spokes; red els (*Cunonia capensis* L.), a furniture wood used also for turnery and spokes; white els (*Platylophus trifoliatus* (Thunb.) D. Don), used for furniture, joinery, boat building and ornamental work; white pear (*Apodytes dimidiata* E. Mey.), employed almost exclusively for cart and wagon felloes; stinkwood (*Ocotea bullata* E. Mey.), a highly valued furniture wood; essenhout (*Ekebergia capensis* Sparrm.), a light hardwood; sneezewood (*Ptæroxylon obliquum* (Thunb.) Radlk.), well known for its durability; beukenhout (*Rapanea melanophlœos* (L.) Mez), used in small quantities for furniture and cabinet making; Cape plane (*Ochna arborea* Burch.), employed for pick and tool handles; black ironwood (*Olea laurifolia* Lamk.), valuable for heavy construction work; yellow woods (*Podocarpus latifolius* (Thunb.) R. Br., *P. henkelii* Stapf, *P. falcatus* (Thunb.) R. Br.), the well-known softwoods of South Africa and terblans (*Faurea macnaughtonii* Phillips) an ornamental proteaceous timber used to some extent for furniture making.

The text has been written on the same plan as in the two previous numbers, but a few changes have been introduced in order to accommodate the larger amount of information available about the silviculture and utilisation of the species described. Kamassi is referred to as one of the only two timbers exported from South Africa, but no mention is made of the second wood, viz. Cape box (*Buxus macowanii* Oliv.). In the circumstances reference might usefully have been made to the use of some of the woods described in the decoration of the new South Africa House, London.

The Use and Misuse of Land. By R. Maclagan Gorrie, D.Sc., F.R.S.E. *Oxford Forestry Memoirs No.* 19. Pp. 80, $10\frac{3}{4} \times 7\frac{1}{2}$. (Oxford: Clarendon Press, 1935.) Price 6*s*.

This report is the outcome of a four months' tour of the United States undertaken by the author, with the aid

of a grant from the Leverhulme Research Fund, to study "The Correlation of Erosion Damage and Grazing in Forest Lands." In addition to this main subject, the report deals with the somewhat wider implications of the use and misuse of forest land and the need for a well-considered land policy to prevent damage and also with the question of erosion control on farm land.

The dangers from soil erosion are now well recognised in the United States and vast schemes of control have been undertaken through the agency of the Forest Service, the Soil Erosion Service, the Tennessee Valley Authority and other organisations. The large amount of data thus made available is recorded and correlated by Dr. Gorrie and should be of great value to those engaged in handling problems of erosion, water supply, flood control and similar matters in other countries.

INSECT PESTS OF GLASSHOUSE CROPS. By Herbert W. Miles, M.Sc., Ph.D., and Mary Miles, M.Sc. Edited by H. C. Long, B.Sc.(Agric.). Pp. x + 174, $8\frac{1}{2} \times 5\frac{1}{2}$. (Surbiton, Surrey: H. C. Long, "The Birkins," Orchard Road, 1935.) Price 8*s*. 6*d*. (by post 9*s*.).

A book dealing with the special problems of insect control in glasshouses has long been needed, not only by commercial growers, but more particularly perhaps by the amateur, who is not catered for by the research and advisory services of the country. This work will go far to meet that need. It deals with the insect pests which attack almost every type of crop grown under glass, from flowers and ferns needing cool or stove conditions, to the crops such as tomatoes, cucumbers and early vegetables and salads, which are now the basis of great industries in some parts of the country.

An introductory chapter deals with glasshouse conditions in relation to the occurrence and control of pests. This is followed by chapters on general soil pests; caterpillars and leaf miners; aphides, capsids and leaf hoppers; white fly, mealy bugs and scale insects; thrips and mites; eelworms and miscellaneous pests such as woodlice, earwigs, ants, slugs, etc. A description of each pest is given in simple, non-technical language and its mode of occurrence and control are briefly but clearly indicated. General methods of pest control in glasshouses, such as soil sterilisation and fumigation, are dealt with separately.

In addition to a full index, there is an alphabetical list of the chief glasshouse crops with their associated pests and characteristic injury, including references to the text pages in which the pest is dealt with more fully. There is

a useful bibliography, while the numerous illustrations further add to the value of the book, which may be safely recommended to all interested in the culture of plants under glass.

Colloids in Agriculture. By C. E. Marshall, M.Sc., Ph.D. Pp. viii + 184, $7\frac{1}{2} \times 5$. (London: Edward Arnold & Co., 1935.) Price 5*s*.

In the usual course of instruction taken by agricultural students, the subject of colloids and their nature recurs, often at infrequent intervals, and usually incidental to some other study. The author of this book considers that the subject of colloids is becoming of such major importance in agriculture that it is desirable for students to obtain a concise idea of the present state of knowledge and theory of colloidal behaviour as a whole, and he has consequently attempted to bring together and render coherent the various phases of colloid chemistry and physics likely to be met with by agricultural students.

The book is divided into three parts. Part I gives a general survey of the whole field of colloids, their nature and formation, the behaviour of molecules and ions at surfaces, the transformation of sols and gels and the water relationships involved. An outline is given of the application of colloidal theory to explain natural phenomena such as winter hardiness and drought resistance in plants.

Part II deals with the various colloidal mineral and organic compounds found in soils, their effect on physical properties and fertility and the role played by colloids in the important phenomena of base exchange. A brief outline is also given of the action of colloids in the formation of different types of soil under varying conditions of climate, rainfall and parent rock. The importance of the amount and the composition of the various soil colloids in determining the texture and field behaviour of soils is also considered.

Part III is concerned with colloids in plant and animal life. The marked predominance of colloidal characteristics in the economy of all living organisms is stated to be due to the fact that only in the realm of colloids is there a sufficiently wide range of properties to cover the essential requirements of all living cells, viz. the necessity for a high degree of permeability in order to permit the easy ingestion of nutrients and elimination of waste products, together with sufficient rigidity for each cell to maintain its own individuality. A brief account is given of some colloidal carbohydrates and proteins found in living tissues and it is emphasised that present knowledge of these substances,

obtained mainly from material separated from the living organism and therefore changed from its original state, is still far from complete. A short chapter is included dealing with what is here termed colloidal architecture in biological structures, with especial reference to the colloidal character and the resulting properties of natural fibres, followed by a consideration of milk and milk products as colloidal systems. The final chapter deals with smoke damage and with the application of colloidal principles to the use of insecticides and fungicides for plant protection.

The book makes no claim to be exhaustive, but it surveys briefly the subject of colloids as applied to agriculture and gives illustrations of the application of recent knowledge to the elucidation of numerous problems. It should meet the needs not only of agricultural students and of those engaged in the application of scientific knowledge and teaching to agriculture, but also of all who, although not specialists in agriculture, nevertheless desire to keep in touch with the application to agriculture of modern research in chemistry and physics.

FARM SOILS. THEIR MANAGEMENT AND FERTILIZATION. By Edmund L. Worthen, M.S. Pp. xiii + 468, 8 × 5½. Second Edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 13*s.* 6*d.*

The first edition of this work, published in 1927, was noticed in this BULLETIN (1928, **26**, 123). Since that date a large amount of new knowledge in soil science resulting from intensive research and experimental field work has become available. Progress has also been made on the manufacturing side in the preparation of new and improved fertiliser materials. Some of the original material has consequently been revised, in order to bring the recommended practice into line with the latest ideas and developments. Certain sections, notably that on fertilising and part of the chapter on liming, have been largely rewritten, a section on the use and meaning of hydrogen-ion concentration and pH value having been incorporated in the latter. There appears, however, to be insufficient emphasis laid on the practical difficulties of translating either pH value or the results of any other method of determining "lime requirement" into the quantity of lime which will be actually needed in the field.

In the chapter on fertilising, also, the importance of many of the less common elements for certain specific crops is not brought out, and with present-day practice

tending constantly to the production of purer and more concentrated fertiliser materials, there is in many localities an increasing risk of deficiency of some of these elements, which were at one time supplied to some extent by the impurities present in artificial fertilisers.

The arrangement of this edition follows closely that of the previous one, a section on " operations " giving practical details of farm work being followed by one of " general information " explaining the principles underlying the practical recommendations. The book should continue to be of use to farmers and vocational students, for whom it is primarily intended, but it must be remembered that it refers solely to American practice. This probably explains why, among the numerous references to further information given at the end of each chapter, there are none dealing with investigations carried out in any country other than the United States.

The Strategy of Raw Materials. A Study of America in Peace and War. By Brooks Emeny. Pp. xiv + 202, $9\frac{1}{4} \times 6$. (New York: The Macmillan Company, 1934.) Price 12*s.* 6*d.*

Strategic materials, sometimes known as " deficiency commodities," have been defined as those substances which are essential to industrial operations, but which are normally available only from foreign sources largely or wholly controlled abroad. Their procurement is therefore a problem of prime importance both in times of peace and especially in war, and has given rise in recent years to a serious study known as the strategy of raw materials.

The present work, directly bearing on this subject, deals primarily with the raw material situation of the United States as contrasted with that of Great Britain, France, Germany, Italy, Russia and Japan. It aims further at answering three important questions relative to American foreign policy, which may be stated as follows: (1) To what extent can the United States, in the event of an extreme war emergency, meet the full demands of self-sufficiency in the essential foodstuffs and industrial materials from its own domestic resources? (2) What sources of supply of strategic commodities are available from foreign countries under various contingencies of war? (3) What measures can be adopted as a means of assuring the self-sufficiency of the United States under any war emergency?

In analysing the United States position, the author has taken, as a basis of discussion, the twenty-six strategic commodities recognised by the United States Department

of Mines. Each of these commodities is described in brief and notes are given regarding its principal uses in war and peace. Then follows an account of the peace-time situation of the United States in respect to this commodity, especially from the points of view of consumption, production and sources of imports. Finally, the probable wartime position of the United States regarding the material is analysed, the author assuming that all imports from abroad will be shut off through blockade for a period of two years following a declaration of war.

Emerging from the discussion comes the important statement that the United States is far better provided for than any other nation with regard to industrial power and self-sufficiency. Of the twenty-six commodities discussed, only six are regarded as of vital or strategic importance in times of war, namely, manganese, chromite, tin, antimony, tungsten and rubber. Twelve others are regarded as "critical raw materials," the term implying that all essential war needs can be met, in an extreme emergency, either through the use of substitutes or an increase in domestic production, or, as in the case of nickel, by obtaining supplies from Canadian sources. These materials include mercury, mica, nickel, manila, sisal, wool, hides, opium, quinine, coconut shells and coffee. The situation regarding the remaining eight materials, namely, nitrates, platinum, camphor, iodine, jute, nux vomica, shellac and sugar, is regarded as relatively secure, since plans have been devised whereby the necessary supplies or substitutes can be obtained. So long as the British Empire remains neutral or is allied with the United States, the author maintains that no problem of procurement would arise in times of war, as these two domains form a perfect unity of supply, with the sole exception of antimony.

The author's analysis is based largely on statistical averages for the period 1925–29 inclusive, and it is possible, in certain cases, to interpret the data otherwise than he has done it in the text and diagrams. Moreover, the advisability of choosing such a period for detailed study is open to question, since world conditions have greatly changed during the past few years. Thus, for instance, on page 115, Canada is represented as the fourth producer of platinum in the world, with an average annual output of 10,500 troy oz., whereas in 1934, Canada, in point of fact, was the world's chief producer with an output of more than 116,000 troy oz. of platinum.

The author, however, is to be congratulated on the great amount of useful information he has skilfully brought together, and the work should prove of considerable value

to all interested in problems of national self-sufficiency and economic sanctions.

ANNUAIRE INTERNATIONAL DES MINERAIS ET MÉTAUX. By Robert Pitaval and Raymond Sevin. Pp. 395, $9\frac{1}{2} \times 6\frac{1}{4}$. 1935 Edition. (Paris: Publications Minières et Métallurgiques S.A.R.L.) Price, France, 50 fr.; abroad, 55 fr.

This valuable work is, for the most part, a directory of the more important mineral producers, consumers, agents, brokers and merchants of the world. It also contains much useful and revised information, taken from R. Pitaval's second edition of *Traité de Commerce des Minerais et Métaux,* a work published in 1923 and containing 1,235 pages, but which, for a number of reasons, has not been issued as a third edition.

The first part of the present work consists of about 180 pages and deals with some forty minerals and metals from an international point of view. Each mineral or metal is considered separately, and, in a number of instances, names and addresses of producers, consumers, etc., are given. Notes are also provided regarding thirty-eight international industrial associations or cartels, as well as on the marketing and production of minerals and metals in 1934.

The second part, comprising approximately 100 pages, gives a detailed and classified list of mines, quarries and metallurgical works in France, together with names and addresses of associated companies. The third part, consisting of about 75 pages, gives similar information regarding the French colonies and French-speaking countries such as the Belgian Congo, Belgium and Luxembourg.

Such a work, consisting, as it does, of less than 400 pages, does not claim to be exhaustive. It is, however, an attractive and useful compilation, well bound in red imitation leather, and thumb-indexed for rapid reference.

MOLYBDENUM STEELS. THEIR MANUFACTURE AND APPLICATION. Prepared for High-speed Steel Alloys, Ltd., by Julius L. F. Vogel, M.I.E.E., M.I.M.M., and W. F. Rowden. Pp. 103, $9\frac{3}{4} \times 7\frac{1}{4}$. (Widnes: High-Speed Steel Alloys, Ltd., 1935.) Price 5*s*.

The manufacture of alloy steels of various kinds has become a very important branch of metallurgical industry in recent years, and there is a rapidly growing amount of general and specialised literature on the subject.

This little volume is a very welcome addition to the information published on molybdenum steel. It deals briefly with molybdenum and methods for the determination of this element, and follows this with clear and concise accounts of the means of adding molybdenum to steel and of the subsequent treatment and properties of the alloy steel produced. Various types of molybdenum steels are then individually considered, and mention is made of special molybdenum steels and alloys.

The book can be recommended as a useful summary of information on present commercial practice in this branch of the steel industry.

LES RESSOURCES MINÉRALES DE LA FRANCE D'OUTRE-MER. IV. Le Phosphate. Pp. 207, $9\frac{3}{4} \times 6\frac{1}{4}$. (Paris: Société d'Editions Géographiques, Maritimes et Coloniales, 1935.) Price 20 fr.

The latest addition to the series of handbooks on the Mineral Resources of the French Colonies deals with phosphates. As usual in these volumes, the subject-matter is divided into several sections, each by a different author, covering diverse aspects of the subject.

After a brief introductory chapter by L. Cayeux on the origin and mode of formation of sedimentary deposits of phosphate of lime, the extensive deposits in French North Africa are described in detail. These lie in the west of Morocco and in Tunis, extending over the border into the east of Algeria. Between them they constitute one of the world's most important sources of supply of phosphate rock, contributing, as they do, nearly half of the total output.

An historical and geological account of the Moroccan deposits is contributed by A. Beaugé, who has included an interesting note on the constitution and powers of the Office Chérifien des Phosphates, the official organisation which, since 1920, has had complete control of the exploitation of all phosphate deposits in the country. It has been estimated that the reserves of high-grade phosphate containing over 75 per cent. of tribasic phosphate of lime in these deposits amount to between 110 and 130 million tons, in addition to an enormous amount of lower-grade phosphate. The methods of mining, treatment and transport used at these mines are described in a chapter by E. Lenhardt.

The sales of phosphate by the Office Chérifien, which were about 8,000 tons in 1921, rose to a maximum of $1\frac{3}{4}$ million tons in 1930, and have since remained at about 1 million tons per annum. It is interesting to note,

however, that only about one-seventh of these sales are made to France.

The phosphate deposits of Algeria and Tunis lie mainly in the latter country and have been exploited for more than forty years, during which time they have contributed about 68 million tons to the world's output. A detailed description of these deposits and their economic significance is provided in a chapter by P. Reufflet. The grade of product is lower on the whole than that of Morocco, the bulk of the production coming within the grade containing from 58 to 63 per cent. of tribasic phosphate. France takes most of her supplies from this source.

The marketing of phosphates, dealt with in a chapter by De Bailliencourt-Courcol, briefly presents a carefully prepared analysis of the phosphate situation of the world in general and of Europe in particular. The point is made that whereas the great increase in European consumption from 1921–30 was met almost wholly by supplies from French sources, the rise in consumption since 1931 has largely been met by supplies from other sources.

The book concludes with a chapter by A. Lacroix on phosphate deposits other than marine sediments, the mechanism of phosphatisation and the minerals met with in various types of deposits. Such deposits occur in France, Madagascar, Indo-China, North Africa and in many islands in the West Indies, the South Seas and elsewhere. Their economic significance is small, but their mode of origin very interesting. It is noteworthy that several deposits of phosphate of alumina occur in some of these islands, some of which have actually been worked.

Each section of the book concludes with a bibliography, and the volume, as a whole, maintains the high standard set by its predecessors in this series.

Limestone and its Products. Their Nature, Production and Uses. By Alfred B. Searle. Pp. x + 709, $9\frac{3}{4} \times 6$. (London: Ernest Benn, Limited, 1935.) Price 42*s*.

This book is divided into twelve chapters, the first four of them dealing with limestones, of which the occurrence, composition and properties, extraction, quarrying and mining, preparation and uses, are considered in detail. In the final eight chapters the materials used in lime burning are briefly dealt with; a long chapter on lime kilns follows; and the various fuels available for the purpose are discussed. The other subjects considered are lime burning; the manufacture of various forms of lime; the utilisation of waste products from lime-works; the storing, packing and despatching of lime, and its uses.

Mr. Searle refers in his preface to the repetition of statements in various sections in order to call the reader's attention to them. This is not a practice to be recommended, and is specially to be deprecated when the statements are inconsistent, as, for example, the table of analyses of limestones, etc., for various kinds of glass on pages 253 and 610. The same percentage figures are attributed to calcium and magnesium carbonate in the first case and to the oxides on the later page. On page 253 also, it is stated that more than 2 per cent. of magnesia in limestone used for glassmaking is undesirable as it is liable to make the glass very viscous and stringy, but on page 619, in discussing the properties of lime used for the same purpose, no drawbacks are mentioned regarding the use of magnesian lime except a tendency for it to contain too much iron, and the reader would gather in this case that the presence of magnesia was not detrimental.

There is a good deal of useful material in this book, and those interested in the subject are indebted to Mr. Searle for summarising so much scattered data. The points mentioned, and other minor errors which were noticed, give evidence of somewhat hasty compilation, which may induce in the reader a lack of confidence in the accuracy of other information. This would be unfortunate, for the book contains much of value.

De Edelsteenen. By Dr. A. Willemse. Pp. 112, 9½ × 6¼. (Eeckeren, Antwerp: Drukkerij Constant van Hoof, 1935.)

This is a paper-covered book in Dutch, written with the object of providing information for jewellers and amateur collectors on simple methods of recognising and judging the value of precious stones. The author contends that handbooks on gemstones do not treat of these aspects sufficiently fully and that many who handle precious stones have a very limited knowledge of them. It may be that these contentions are more justifiable in Holland than in England and the United States, where organisations exist for the specific purpose of providing facilities for those who wish to acquire a scientific knowledge of precious stones.

The text is in two sections, the first dealing with physical properties and the means of detecting and measuring them, and the second containing descriptions of all the usual gemstones. In the first section, after describing hardness, specific gravity, refractive index and dichroism, there is an interesting chapter on inclusions, electrical properties and imitation stones of various kinds. In the

second section the various stones are arranged according to their colour, a system which involves a good deal of cross-reference and some repetition, as different gemstones are often merely differently coloured varieties of the same substance.

The descriptions given are fully adequate and contain the kind of information which is likely to be of use to the readers for whom the book is written. Wherever possible the approximate value of each stone is given (in Dutch currency), and in this respect the book provides information which is very difficult to obtain from other sources.

Industrial and Manufacturing Chemistry. Part II, Inorganic. A Practical Treatise. Volume I. By Geoffrey Martin, D.Sc., Ph.D., F.I.C. Pp. xix + 496, $9\frac{3}{4} \times 6\frac{1}{4}$. Fifth Edition, Revised. London: (The Technical Press, Ltd., 1935.) Price 28*s.*

It is stated in the preface to this volume that an attempt has been made to keep the book up to date, but it is disappointing to find that the text, including the misprints, is largely identical with that of the first edition, published in 1917.

Many developments have taken place in applied chemistry in the last eighteen years, but, for the most part, they are noticed in this edition only by the inclusion of scanty references to recent literature, and by the addition of short paragraphs or occasionally statistics, apparently only when this could be done without interfering with the set-up of the type and pagination. In Section VIII, for example, on Refrigerating and Ice-making Machinery, there are three additions to the preliminary bibliography, but there is no mention in the text of the use of methyl chloride, fluorinated hydrocarbons and other carbon compounds for refrigeration purposes. In some sections the reader is referred to early editions of publications of which much later revisions are available.

The need for drastic revision of most of the statistics is well shown by reference to the sections dealing with sodium carbonate, iodine and gypsum. The latest figures given for the world production of sodium carbonate, bicarbonate and caustic soda are for 1884; the last complete table for gypsum is for 1910, while iodine figures stop at 1908. Such out-of-date statistics are apt to be misleading; thus, in the case of gypsum, some present-day important producers do not appear in the table, and the relative importance of others has altered considerably since 1910.

The extent to which the reader may be misled by other out-of-date information is well illustrated by reference to

the section on compounds of boron. Here we are led to understand that principal sources of borates are the minerals ulexite, colemanite and pandermite, and processes are described for the preparation of borax from those substances. No mention is made, however, of the extensive deposits in California of the mineral kernite, which since 1927 has largely displaced the other natural borates referred to by the author.

A general treatise on industrial chemistry, such as this, should serve a useful purpose, and it is to be hoped that before the next edition is published Dr. Martin and his collaborators will take the matter of revision seriously in hand.

A German-English Dictionary for Chemists. By Austin M. Patterson, Ph.D. Pp. xx + 411, $7\frac{1}{4} \times 5$. Second Edition. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 15*s*.

Advances in science, since the publication of the first edition of this extremely useful work in 1917, have brought many new words into scientific and technical vocabularies. In preparing this revised and enlarged second edition, Dr. Patterson has received help from a number of other chemists and has spared no pains to bring his book up to date. It contains sixty-eight more pages than the last edition and thus room has been found for new entries relating not only to chemistry, but to bacteriology, biology, metallurgy and other technical subjects. Opportunity has also been taken to include many new contractions. Further space has been gained by eliminating uncommon words and words unlikely to be met with in scientific works. The book, nevertheless, remains an adequate general dictionary and is consequently able to come to the rescue of the many readers of scientific German whose inadequate knowledge of the language leaves them floundering in difficulties with non-technical as well as with technical words.

The pleasing binding, clean type and clear layout of the first edition have been retained and the publishers, as well as the author, are to be congratulated on producing such a serviceable volume.

Why the Weather? By Charles Franklin Brooks, Ph.D., with the collaboration of Eleanor Stabler Brooks and John Nelson. Pp. xvii + 295, $8 \times 5\frac{1}{2}$. Revised and Enlarged. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 10*s*. 6*d*.

Although Dr. Brooks is Professor of Meteorology at Harvard University, this is not a textbook, but is largely

a compilation of popular weather " notes " by the author, partly with journalistic collaboration, that have appeared in various American and Canadian newspapers. Some readers may like to work through the book from beginning to end, but more will probably turn to the index, which will direct them to instruction and entertainment under such headings as : Beware the Barometer ; Why the Sky is Blue ; How Icicles Form ; Why Stars Twinkle ; How to use a Weather Map ; or Thunderstorms and the Vacationist.

The numerous photographs, mostly sponsored by the United States Weather Bureau, enhance the attractiveness of the book.

BOOKS RECEIVED FOR NOTICE

GREEN HAVOC IN THE LANDS OF THE CARIBBEAN. By C. W. Wardlaw. Pp. 318, 8½ × 5½ (Edinburgh and London : William Blackwood & Sons, Ltd., 1935.) Price 12*s*. 6*d*.

DIE ÖLBOHNE ODER SOJA. By Dr. Arnold Kornfeld. Pp. 32, 8½ × 5½. (Hamburg : Tropenverlag Fr. W. Thaden.) Price RM. 1.40.

REPORT OF THE FOREST PRODUCTS RESEARCH BOARD FOR THE YEAR 1934. Department of Scientific and Industrial Research. Pp. vi + 75, 9½ × 6. (London : His Majesty's Stationery Office, 1935.) Price 1*s*. 6*d*.

A GENERAL INTRODUCTION TO FORESTRY IN THE UNITED STATES. By Nelson Courtlandt Brown. Pp. xix + 293, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman & Hall, Ltd., 1935.) Price 16*s*.

A TEXTBOOK ON FOREST MANAGEMENT. By M. R. K. Jerram, M.C. Pp. x + 156, 8½ × 5½. (London : Chapman & Hall, Ltd., 1935.) Price 10*s*. 6*d*.

THE CHEMISTRY OF SYNTHETIC RESINS. By Carleton Ellis. Volume I, Pp. 1–829; Volume II, Pp. 830–1615, 9 × 6. (New York : Reinhold Publishing Company ; London : Chapman & Hall, Ltd., 1935.) Price £4 17*s*. 6*d*.

HISTORICAL GEOLOGY OF THE ANTILLEAN-CARIBBEAN REGION. By Charles Schuchert, D.Sc., LL.D. Pp. xxvi + 811, 9 × 6. (New York : John Wiley & Sons, Inc. ; London : Chapman& Hall, Ltd., 1935.) Price 50*s*.

THE BOOK OF MINERALS. By Alfred C. Hawkins. Pp. xii + 161, 7½ × 5. (New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd., 1935.) Price 7*s*. 6*d*.

TECHNICAL DATA ON FUEL. Edited by H. M. Spiers, M.A., B.Sc., F.I.C. Fourth Edition. Pp. xvi + 358, 7½ × 5. (London: The British National Committee, World Power Conference, 1935.) Price 12*s*. 6*d*.

DAS O-OXYCHINOLIN "OXIN." By Dr. Richard Berg. Pp. vii + 94, 10 × 6½. (Stuttgart: Ferdinand Enke Verlag, 1935.) Price, bound, RM. 10.20; unbound, RM. 8.80.

ELECTROLYTIC OXIDATION AND REDUCTION: INORGANIC AND ORGANIC. By S. Glasstone, D.Sc., Ph.D., F.I.C., and A. Hickling, M.Sc., Ph.D. Being Volume Nine of a Series of Monographs on Applied Chemistry under the Editorship of E. Howard Tripp, Ph.D. Pp. ix + 420, 8½ × 5½. (London: Chapman & Hall, Ltd., 1935.) Price 25*s*.

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Scientific names and titles of books are printed in italics and authors' names in capitals